SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

SEPTEMBER 1902.

GENERAL PHYSICS.

1655. *Mercury Air-pumps.* **G. W. A. Kahlbaum.** (Ann. d. Physik, 8. 2. pp. 466–471, May, 1902.)—This paper contains a reply to F. Neesen's criticism [see Abstract No. 1271 (1902)] on G. W. A. Kahlbaum's paper on air-pumps [see Abstract No. 1 (1902)]. The use of the different luminous effects successively obtained in the exhaustion of a Crookes' tube, as standards of pressure, is considered to be unsatisfactory, for the reasons that the eye is not able to detect with sufficient rapidity the first appearance of each effect, and also that the effects are liable to vary with the current. Replies are also given to the other points raised. C. K. F.

1656. *Cavendish Balance.* **G. K. Burgess.** (Phys. Rev. 14. pp. 247–256, April, 1902.)—A modification is described in which the weight of the turning system is compensated by a float immersed in a mercury bath, and any capillary action is eliminated that might tend to hinder the mobility of the system. Any degree of sensitiveness can be obtained. Preliminary experiments gave the constant of gravitation $6{\cdot}64\ 10^{-8}$ and the earth's density 5·55. [Summary of a Sorbonne thesis, 1901: work done under Prof. Lippmann.] A. D.

1657. *Divergence of Long Plumb-lines in a Deep Mine.* **F. W. McNair.** (Eng. and Mining Journ. 73. pp. 578–580, April 26, 1902.)—The plumb-lines were used to transfer an azimuth from the surface to an underground level, and were 4,250 ft. in length, greater than in any case previously recorded. They consisted of No. 24 piano wire, and the bobs were of cast iron, weighing 50 pounds each, the latter being swung in pails of cylinder oil for damping the vibrations. Measurements between their upper and lower extremities showed a divergence of 11 ft. Magnetic and other disturbances were suggested and sought for, but, after a very thorough investigation, the displacement was found to be simply due to air-currents. G. G.

1658. *New Hygrometric Method.* **E. B. H. Wade.** (Phil. Mag. 3. pp. 380–385, April, 1902. Paper read before the Physical Society, Dec. 13, 1901.)—The note describes a new hygrometric method in which the thermometer is wetted, not with water, but with sulphuric acid of suitable strength, and it is claimed that the method is (1) theoretically sound, (2) cheap and easy to manipulate, (3) specially suited for the study of ordinary wet-bulbs, (4) independent of ventilation. A description of the theory and method of manipulation is given, and tables of results are cited. J. W. P.

1659. *Films of Minute Metallic Particles.* **R. W. Wood.** (Phil. Mag. 3. pp. 396–410, April, 1902. Paper read before the Physical Society, March 14, 1902.)—The author has made "metallic deposits on glass, which the microscope shows to be made up of particles smaller than the wave-lengths of light, and which by transmitted light, exhibit colours quite as brilliant as those produced by aniline dyes." The deposits are obtained by heating small fragments of the alkali metals in glass bulbs thoroughly exhausted and sealed, the method of preparation being described in detail. Sodium films were prepared, coloured deep purple, blue, apple-green, or red, according to conditions. Some of the more transparent films, examined under a $\frac{1}{12}$ in. oil objective, proved to be composed of particles just barely visible as individual grains lying close together. When air is admitted into the tube the colour vanishes instantly, but pure hydrogen has no effect. The diameter of the particles varies from 0·0003 to 0·0002 mm. Coarse particles diffract or scatter the light, minute particles very close together regularly reflect those wave-lengths absent in the transmitted light, and minute particles far apart diffuse light of the same wave-lengths as those which are, to some extent, absent in the transmitted light. Heating and cooling both affect the colour in such a way that the absorption region of its spectrum shifts in the direction of greater wave-lengths, but the effect due to cooling is temporary. Thus a pale green film becomes deep violet when cooled. Some films are so sensitive that the change and return of colour can be produced by merely blowing, and then rubbing with the finger. The films are practically electrically non-conducting, and the maximum polarisation of light is obtained at about 135° to the incident ray. The author suspects the phenomena to be due to a kind of electrical resonance. G. E. A.

1660. *Dynamical Aspect of Stability of Structures.* **A. Sommerfeld.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 391–394, March 15, 1902. Paper read before the Aachener Bezirksverein, July 3, 1901.)—In a structure such as a pillar subject to varying load, considerations of resonance come in, and the real or dynamical displacement is not the statical displacement for the maximum load, but is equal to the latter multiplied by a "dynamical coefficient" γ. A similar statement holds for a flywheel subject to a periodic couple. For a pillar built in at the bottom, for instance, γ depends on the load, the weight of the pillar, the Young's modulus of its material, the moment of inertia of its section, its length, and particularly on the frequency of variation of the load. For very small frequency γ is approximately unity, while a critical frequency is reached for which the dynamical displacement is much greater than the statical, decreasing for higher frequencies. The critical frequency is that for which the period of the load is the natural period of the pillar, and must in practice be avoided; this may be effected in various ways, the safest in practice being to increase the section of the pillar till the natural frequency of the pillar is, say, ten times that of the load. The author considers also the case of a flywheel governed by the torsional couple in a spring, and shows that in this case the usual statical methods may lead to serious error. The results were illustrated by experiments. W. S.

1661. *Specification of Stress and Strain in an Elastic Solid.* **Kelvin.** (Phil. Mag. 3. pp. 444–448, April, 1902.)—This is a continuation of Kelvin's former paper [see Abstract No. 1023 (1902)]. He introduces for perspicuity an auxiliary tetrahedron, similar to the tetrahedron A B C D of the former article, defined by the relation that $\alpha\,\beta\,\gamma\,\delta$, the angles of the new tetrahedron, are the centres of gravity of the four triangular faces of A B C D. By this and the former paper he has completed, he says, the foundation of the molar dynamics of an elastic solid of the most general possible kind according to Green's theory, without restriction to infinitely small strains. The rest of the present paper is occupied with the geometry of tetrahedrons and of the strain ellipsoid. Let, for instance, a sphere be inscribed touching each of the six edges of an equilateral tetrahedron in their middle points, and having, therefore, its centre at K, the centre of the tetrahedron. When the solid is altered by homogeneous strain, the inscribed sphere becomes the strain ellipsoid, which still has its centre at K, and touches the six edges of the altered tetrahedron at their middle points. S. H. B.

1662. *Stability of Equilibrium of a Pear-shaped Rotating Fluid.* **H. Poincaré.** (Roy. Soc., Phil. Trans. 198. pp. 333–373, April 5, 1902.)—The present paper is a continuation of the author's memoir on the same subject ("Acta Mathematica," vol. 7). It should be read in connection with that former memoir, and with the recent papers by G. H. Darwin, on "Ellipsoidal Harmonics," and on the pear-shaped figures.

We are to suppose a series of Jacobian ellipsoids of stable equilibrium becoming more elongated until we arrive at the "critical Jacobian," or "ellipsoid of bifurcation," which is also the limit of the series of pear-shaped bodies. It is defined, according to Darwin, by the vanishing of one of the coefficients of stability. Darwin has also determined its axes, namely, 1·88583, 0·81498, 0·65066. In the present paper ω denotes the angular velocity, and J the moment of inertia, of the body under consideration. For the critical Jacobian these are denoted by ω_0 and J_0. Further, the equation of the critical Jacobian is

$$\frac{x^2}{\rho_0^2-a^2}+\frac{y^2}{\rho_0^2-b^2}+\frac{z^2}{\rho_0^2-c^2}=1,$$

And the elliptical co-ordinates, ρ, μ, ν, used in this paper are derived from it. The criteria of stability may be presented in either of two forms. We may make, that is, $U+\frac{1}{2}\omega^2 J$ a minimum, given ω, where U denotes the potential; or we may make $U-\frac{1}{2}\omega^2 J$ a minimum, given ωJ. The first condition is applicable, our author says, to Plateau's experiments, in which the fluid is carried round frictionally by a rotating axis. The second is necessary and sufficient for a homogeneous mass of fluid isolated in space. As we arrive at the critical Jacobian from either series, viz., from the series of Jacobian ellipsoids, or that of the pear-shaped bodies, ω, and likewise ωJ, must be either a maximum or a minimum, and the question is which. M. Poincaré adopts, as the more probable, the hypothesis that ωJ is a minimum at the critical Jacobian, and makes use of the second of the two criteria of stability. The notation employed in this paper is not precisely identical, either with the author's own in the "Acta Mathematica," or with Darwin's. He makes use of the functions R, S, M, N, defined by Lamé and in previous investigations, R having five forms denoted by five indices, R_1, R_2, R_3, R_4, R_5, which are calculable when the axes of the critical Jacobian are known. Of these, R_5 is "the third zonal harmonic," and is the most important for the present investigation. The pear is defined as follows: From the surface of the critical Jacobian draw normals to the confocal ellipsoids, that is, the lines $\mu=$ constant, $\nu=$ constant. If $d\sigma_0$ be an element of surface of the critical Jacobian, dv the volume formed by $d\sigma_0$, and these lines drawn from points on its boundary, the ratio $dv/d\sigma_0$ is the distance between $d\sigma_0$ and a new surface, and is a function of μ, ν, which he developes in a series of Lamé's functions ξ_1, ξ_2, &c., in the form $dv/d\sigma_0=\Sigma C\xi_i M_i N_i$. The surface so formed is the pear, and is defined by the ξ coefficients.

We may consider the attracting matter in the space between the pear and the critical Jacobian (the distribution C) as all collected on the surface of the critical Jacobian. Hence is calculated the difference between the attraction of the distribution C and that of the supposed distribution on the critical Jacobian (Σ). The conditions of stability for the pear are finally given in the new form—

$$\frac{\omega J-\omega_0 J_0}{\omega_0 \xi_3^2}=T-XY/T<0 \text{ (p. 362)},$$

in which T and Y are quantities which he has proved to be negative. He has also found (p. 362)—

$$\xi_3^2 X+\epsilon T=0,$$

where ϵ is defined as follows: ω_0 being the angular velocity of the critical Jacobian, that of the pear is $\sqrt{\omega_0^2+2\epsilon}$. For stability it is sufficient and necessary that ωJ should be a minimum, that is, $\omega J-\omega_0 J_0>0$. But, as proved by the author, $\epsilon<0$. Therefore, since $\xi_3^2 X+\epsilon T=0$, X must be negative, and this he gives as the final condition for stability. S. H. B.

1663. *A Law of Molecular Attraction.* **J. W. Mellor.** (Phil. Mag. 3. pp. 423–424, April, 1902.)—Van der Waals' well-known formula makes the final of the intermolecular forces in a liquid or vapour vary as the square of the density, on the assumption that the density is at every instant constant throughout the substance except at points very near the boundary, and that the intermolecular forces exactly balance each other always and at all points, except very near the boundary. The author, in the paper, deduces from Van der Waals' formula Sutherland's law, namely, that molecules act on each other with a force varying as the inverse fourth power of the distance. S. H. B.

1664. *Deformation of a Right Isotropic Diedron with Special Boundary Conditions.* **R. Marcolongo.** (Accad. Lincei, Atti, 11. pp. 318–324, April 20, 1902.)—This note refers to Somigliana's paper [see Abstract No. 1285 (1902)], in which is treated the problem of the deformation of a right isotropic diedron with two planes of symmetry, when the displacements and the forces at the bounding surfaces are each given in part. The writer here proposes to show that the general method of Betti-Cerruti can easily be applied to Somigliana's problem. The solid in question is bounded by the half planes $x=0$ and $z=0$ (back); on the boundary $x=0$, $\partial G/\partial x=\partial(1/r)/\partial x$, and on the boundary $z=0$, $G=1/r$. Corresponding to any point M_1 in the solid there are three successive images in the planes $z=0$, $x=0$, and $z=0$. The distances from any other point M of M_1 and the three images respectively are r, r_1, r_2, and r_3. Thus, if $G=1/r_2+1/r_3-1/r_1$, G satisfies the condition. Also G satisfies the harmonic condition, $\nabla^2 G=0$, at all points within the solid. This solves the problem for the case in which, on the plane $x=0$ the values of the normal $\frac{\partial u}{\partial x}$, and on the plane $z=0$ the values of u itself are given. From this can be found the deformation of the same solid when subjected to any forces, when on one bounding plane the tangential components of displacement, and on the other the normal components of force are given. If ξ, η, ζ, be the component displacements, the first step to the solution is to find displacements corresponding to zero force with bounding conditions—

$$\text{on } x=0,\ \partial\xi/\partial x = -\partial^2(1/r)/\partial x^2,\ \eta = -\partial(1/r)/\partial y,\ \zeta = -\partial(1/r)/\partial z\,;$$
$$\text{on } z=0,\ \xi = -\partial(1/r)/\partial x,\ \eta = -\partial(1/r)/\partial y,\ \zeta = -(\partial^2(1/r)/\partial z^2.$$

This displacement ξ, η, ζ, is called the auxiliary displacement. The problem is next to determine the forces to be applied at the boundary in order to produce the auxiliary displacement. From this auxiliary displacement is also found the cubic dilatation (H), at any point, corresponding to the effective deformation, and from this u, v, w are found. Finally, the writer treats the converse problem, in which the normal displacements and the tangential forces are given on the bounding surfaces. S. H. B.

1665. *Particular Solutions of a Hamiltonian System.* **P. Burgatti.** (Accad. Lincei, Atti, 11. pp. 309–314, April 20, 1902.)—If in a system of n degrees of freedom, in which Hamilton's canonical equations are $dq_i/dt = d\text{H}/dp_i$, $dp_i/dt = d\text{H}/dq_i$, k integrals, or invariable relations, are known, which determine $p_1\, p_2 \ldots p_k$, then Levi Civita's theorem asserts that "if H_1 be what H becomes when for $p_1 \ldots p_k$ we substitute the values deduced from the k integrals, the relations $d\text{H}_1/dp_i = 0$, $d\text{H}_1/dq_i = 0$, $(i = k+1 \ldots n)$, together with those supposed known, constitute a system invariable with respect to the canonical equations." From these equations and the known integrals, the p's and $q_{k+1} \ldots q_n$, can be found as functions of $q_1 \ldots q_k$, and thence, by substitution in the canonical system, we have a system of equations reduced in number by k, from which $q_1 \ldots q_k$ can be found as functions of the time. The motions so obtained are stationary motions in the sense used by Routh and Levi Civita. The object of the present paper is to connect the above theory with the general theory of differential equations. S. H. B.

1666. *Minimum Temperatures at St. Louis, Mo.* **W. H. Hammon** and **F. W. Duenckel.** (Monthly Weather Rev. 30. pp. 12–13, Jan., 1902. Paper read before the St. Louis Academy of Science, March 2, 1896. (Abstract).)—There are two meteorological stations at St. Louis where bituminous coal is burned, the U.S. Weather Bureau, which is on all sides surrounded by chimneys, and the Observatory in the large Forest Park, which is generally free from smoke. The temperature minima at the former station are almost always higher than those at the latter, especially with clear skies and light winds, by 9° F. in September, and by 1·5° F. in December on average, owing probably to the accumulation of smoke. H. B.

1667. *Temperature Variations at High Altitudes.* **L. Teisserenc de Bort.** (Comptes Rendus, 134. pp. 987–989, April 28, 1902.)—The paper gives the results of recent temperature measurements made at high altitudes by means of balloons sent up from the French Observatory for Dynamic Meteorology. The decrease of temperature with increase of altitude augments after the lower strata have been left, and reaches, in regions heretofore explored, a value pretty near that which corresponds to the adiabatic variations of dry air, but this decrease, instead of continuing, as had been anticipated, in the same ratio, was found to reach a maximum, and then rapidly diminish until it became practically nil at an altitude of about 11 km. Above an altitude, varying, according to the atmospheric conditions, between 8 km. and 12 km., a zone, extending apparently for several km., is reached, in which there is very little decrease, or even a slight increase, of temperature, spells of heat and cold alternating. This is of serious import for the general study of air circulation. A study of the observations show that the kink in the regular curve of decreasing temperatures occurs at elevations between 8 km. and 13 km. It appears that the diminution of the decrease in temperature corresponding to an increase in altitude which takes place at elevations between 8 km. and 9 km. coincides with periods of atmospheric disturbances and barometrical low pressure, while, under conditions of high pressure, the point at which the regular decrease in temperature stops, and the temperature shows a tendency to become fixed, is raised. The results above stated confirm the author's previously reported discoveries [see Abstract No. 644 (1902)], and supply additional data of great interest. He has recently endeavoured to establish a connection between the variations in the altitude at which the divergence of the curve begins and the general atmospheric conditions, and gives data showing that the isothermal zone near to 12·5 km. in the central portion, north of the area of strong pressures, sinks to 10 km. in the centre of the areas of feeble pressures. G. G.

1668. *The Climatic Conditions of Turin during the yeaı* 1901. **V. Balbi.** (Accad. Sci. Torino, Atti, 37. 10a. pp. 221–249, 1901–1902.)—The paper gives, chiefly in the form of classified tables, data for the temperature, moisture, winds, sunshine, pressure, &c., prevailing in Turin during 1901. The year was characterised by its exceptional humidity; it interrupted, too, the series of years with a temperature notably above the average. D. H. J.

1669. *The Physical Basis of Long-range Weather Forecasts.* **C. Abbe.** (Monthly Weather Rev. 29. pp. 551–561, Dec., 1901.)—This paper is a summary of lectures delivered at the Johns Hopkins University during February, 1901. It contains a lucid digest of the physical conditions to be taken into consideration, and of the progress that has been made in dealing with them. The author's conclusion is that it is only by the study of these general phenomena and their elucidation that we can expect to realise satisfactory long-range weather forecasts, and that this result will be better and earlier attained by the study of the mechanics of the atmosphere than by the search for elusive empirical periodicities. G. W. DE T.

1670. *Cause and Mechanism of Heat-waves.* **H. M. Watts.** (Frank. Inst., Journ. 153. pp. 285–293, April, 1902.)—The causes of heat-waves, in whatever part of the globe, are due to exactly the same general conditions. Local differences exercise no important effect. The meteorological mechanism is simple. The origin is invariably due to a certain stress in the shape of a barometrical high-pressure area in the general circulation, which sets up a movement of air from the tropics toward the polar region. This stress, which is far reaching, its reaction extending all around the globe, slows up, as far as the northern hemisphere is concerned, the normal eastward drift of the serial eddies in the north temperate zone, producing a stagnation in the lower atmospheric levels. The local circulation thus set up modifies the moisture content in the upper levels of the lowermost stratum of the atmosphere, by which radiation at night is checked, and the air thus retains an abnormal amount of the heat gained during the day. Thus vast areas of land favourably situated become overheated, being covered, so to say, by a blanket of superheated air, extending upward to the higher cloud level. The duration and extent of the heat-waves so caused remain unaffected by local conditions, and a change can be brought about only by a reversal of the south-to-north system of circulation. Heat-waves, therefore, form a part of the so-called fixed and permanent characteristics of the general circulation of the globe, which is characterised by a belt of high pressures near the tropics and a belt of low pressures near, or at, the poles, between which two permanent belts move, in a great eastward swirl, the enormous aërial eddies that condition weather and climate in the temperate zone. Of these aërial eddies, there are only two, *i.e.*, the high-pressure, anticyclonic, downdraught eddy, and the low-pressure, cyclonic, updraught eddy, the former being the centre of clear weather phenomena, the latter that of stormy and cloudy weather. The cause of the reversal in the direction of the circulation from the tropical regions poleward, and the definite shift in the atmospheric stresses, which alone can terminate the duration of the heat-wave, must be found in the sun, and are certainly regulated by law. The author hopes that by the careful study of the cosmological conditions, this law may soon be discovered, and that meteorologists will thus be enabled to forecast seasonal conditions, and to predict with accuracy whether the summer will be hot or cool. A great step will have been reached in the effort of finding the true rhythm in what appear to be capricious changes in the weather of the temperate zones, as soon as it has become possible to forecast the character of the tropical and subtropical regions. G. G.

1671. *Nova Persei Nebula.* **W. E. Wilson.** (Roy. Dublin Soc., Proc. 9. pp. 556–558, April 14, 1902.)—The author outlines the view, first stated by Kapteyn, that the variations which have been noted in the surrounding nebulosity of Nova Persei are due to the successive lighting up of the outer extensions of a previously existent nebula by the advancing wave front of the light from the main disturbance.

Adopting this view, the distance of the Nova from the earth can be calculated when we know the velocity of light and the angular displacement of the nebulosity in a given period of time. His result gives the distance of the new star as about 248 *light years, i.e.*, 15,780,000 times the distance of the sun from the earth. Arguments are presented for supporting the view that the nebulous matter has a sufficiently high albedo to reflect enough light at this distance. The method, if true, becomes of extreme importance, in that the distance of a celestial body whose parallax is unknown may be thus determined.

C. P. B.

REFERENCES.

1672. *Level Tester, by Bamberg.* **C. Aimonetti.** (Accad. Sci. Torino, Atti, 37. 5a. pp. 119–136, 1901–1902.)—A description of the testing of the instrument is given. A. D.

1673. *Coefficient of Diffusion from Optical Data.* **J. Thovert.** (Comptes Rendus, 134. pp. 594–596, March 10, 1902.)—Numerical data obtained by the method referred to in Abstract No. 432 (1902) with certain described modifications. A. D.

1674. *Effect of Pressure on Curved Surfaces.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 333–341, March 8, and pp. 375–380, March 15, 1902.)—An experimental investigation to determine formulæ expressing the power of resisting pressure when applied to the convex surfaces of copper and iron vessels.

W. W. H. G.

LIGHT.

1675. *Absorption of Light Rays by Thin Layers of Metal.* **E. Hagen** and **H. Rubens.** (Deutsch. Phys. Gesell., Verh. 4. 5. pp. 55–63, March 7, 1902. Communicated by the Physikalisch-Technischen Reichsanstalt.)—The infra-red, visible and ultra-violet rays from an arc lamp are examined, before and after interposition of the metals, by means of a special spectroscope used in former experiments. [See Abstracts Nos. 452 and 1049 (1902).] The metals Au, Ag, and Pt are deposited chemically, and by means of kathode rays on quartz plates, and the thickness (*d*) of the layer determined by weighing, or by a chemical method. A table of values is given of the coefficients of absorption (*a*) and of extinction (*g*), these being calculated from: Intensity after transmission = intens. before $\times 10^{-ad}$, and $g = a\lambda/4\pi M$, where M is the log. modulus. For equal thicknesses gold is the most transparent to visible rays, platinum the most absorbent. Silver has a maximum transparency for $\lambda = 0{\cdot}321\ \mu$, when it is 1,200 times as transparent as platinum. The results for silver are compared with those of Jamin, Quincke, Drude, and Wernicke, those for silver deposited by kathode rays agreeing with Wernicke's results. The numbers for chemically deposited silver are somewhat larger. The indices of refraction are calculated from the reflecting power and the extinction coefficient. The sequence of the metals as regards absorption is the same as for electric conductivity. G. E. A.

1676. *Optical Properties of Asphalt.* **E. L. Nichols.** (Phys. Rev. 14. pp. 204–213, April, 1902.)—In the first set of observations a thin layer of asphalt was obtained by dipping a piece of plate glass in asphaltum varnish and allowing it to dry. A one-prism spectroscope was used, and comparisons of the absorption spectra obtained from similar acetylene flames, through the glass alone, and through the glass and varnish, were made. The extinction coefficients for wave-lengths from 7,300 to 5,890 Angstroms, were thus obtained, and a transmission curve for the visible spectrum is shown. An almost complete opacity in the yellow is found. The layer used here was about 0·003 cm. in thickness, but by another method of preparation a layer 0·00005 cm. thick was obtained, and this gave similar results. To determine the dispersion of asphalt, a prism of angle 1° 50′ 2″ was made. This was examined by a two-prism spectrometer, and the indices of refraction for several wave-lengths were found.

Measurements in the infra-red were made by a Nichols radiometer, the deflections being taken first with the radiometer exposed to the absorption spectra, secondly to the spectrum of the uninterrupted rays from the flame. The author concludes that these optical properties may be due to particles of carbon dissolved or suspended in the medium of the varnish. There are, however, on the other hand, many differences between the optical behaviour of asphalt and carbon. J. W. P.

1677. *The Influence of the Atomic Weight on the Absorption, Dispersion, and Colour of Transparent Bodies.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 4. 8. pp. 138–166, April 25, 1902.)—For the present purpose the author used, in almost all cases, the method already described by him. [See Abstract No. 302 (1902).] An examination of the data given in the paper here presented leads to the following general conclusions :—

(1) For a number of transparent non-conducting elements (C, P, S, Cl, Se, Br, I), the wave-length corresponding to the principal absorption band in the ultraviolet is approximately proportional to the square root of the atomic weight ; this wave-length is independent of the state of aggregation of the element, and is unchanged in solution. (2) The absorption band, λ, of an element A such as those mentioned, remains nearly unaltered when A combines chemically with another element B ; there occurs usually, however, some little displacement of λ, but this displacement appears to be the less, the more A atoms there are in the molecule. (3) The metals, in their transparent compounds, give rise to characteristic absorption bands, which appear more in the region of longer waves as the atomic weight of the metal increases. D. H. J.

1678. *Photophonic Books for the Blind.* **V. de Turine.** (Écl. Électr. 31. pp. 16–19, April 5, 1902.)—A sheet of transparent paper contains, printed upon a black background, a number of small white squares, separated from each other by intervals one, two, or more lengths of a square in size. These squares, together with the intervals, represent the letters of the alphabet, exactly as do the dots and dashes of Morse. In order to enable the blind to read these letters, the printed sheet is placed in a frame between two thin plates of glass fully exposed to the light, and an opaque piece of cardboard, or some other material, with a square-shaped opening in the centre, is moved by the reader along the printed lines from left to right. Whenever the opening passes over one of the white transparent squares, the rays of light illuminating the printed sheet pass through this opening, and, by means of a photophonic apparatus, are changed into sound. In this way, the blind reader receives the letters in the form of sounds separated by longer or shorter intervals of silence, and his ear fulfils the functions of the eye. There exists a great variety of photophonic devices that can be used for transforming the rays of light into sound for the purpose above stated. Thus the light may be made to impinge upon a plate of selenium intercalated into a circuit fed by a galvanic battery, so that whenever the light falls upon the selenium and permits the currents to pass through it, a slight sound is caused in an electromagnetic apparatus attached to the circuit. Or a Wheatstone bridge may be used, fed by an alternating or intermittent current, the generator of which is situated in one of the diagonals, while the other contains a telephone, and a plate of selenium is intercalated in one of the branches, the bridge being so balanced that the telephone remains silent as long as no light falls upon the selenium, while the moment that the latter is illuminated it emits a sound. In a third method a differential telephone fed by alternating or intermittent currents is used, which, in one of its circuits, contains a plate of selenium ; the two circuits being so balanced that the currents neutralise each other, and no sound is heard as long as no rays of light impinge upon the selenium. These methods and many similar ones will be quite suitable for the desired object. Instead of photophonic devices based on the characteristic qualities of selenium, others may be used resembling the apparatus of Mercadier, in which the diaphragm of a microphone is covered with lamp-black and serves as the bottom of an air-tight box, the cover of which is a glass plate. The microphone is intercalated in the circuit of a galvanic battery, which also contains the primary of an induction coil, the secondary of which is connected with a telephone. The light falling upon the blackened diaphragm produces, as in the case of selenium, the conditions required for the absence of sound in the telephone. G. G.

1679. *Photography applied to Architectural Measurement and Surveying.* **J. B. Lee.** (Soc. Arts, Journ. 50. pp. 493–503; Discussion, pp. 503–504, April 18, 1902.)—Starting from the geometrical relationship between objects and the images of those objects, the author shows that by knowing the station points from which the picture was taken, marking the horizontal and the vertical picture plane on each print, marking the orientations, and knowing the distance lines of the perspective, it is possible very readily to compare photographs from different standpoints so as to plot ground plans and estimate altitudes from these alone. Trafalgar Square is used as a practical illustration, with diagrams. A. D.

1680. *Rotation of Polarisation Plane in Moving Bodies.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 793–804, March 29, 1902.)—In his "Versuch einer Theorie, &c.," the author gives for the rotation of the polarisation plane per unit of length the following formula, $\omega = 2\pi n'^2 j/\sigma^2$, for the case of the medium being at rest, and—

$$\omega = \frac{2\pi}{5^2} n'^2 \left(1 + \frac{W g_x}{c^2}\right) j + \frac{2\pi}{\sigma^2} n'^2 W g_x k,$$

for the case of a translation in the direction of the x-axis, the light travelling in the same direction. In these formulæ, n' is the frequency for an observer taking a part in the translation, W the mean velocity of circularly polarised light in the stationary medium, c the velocity of light in the ether. Now, J. Larmor ("Ether and Matter," Cambridge, 1900), having opposed those deductions, the author proceeds to revise his theory. In this paper it is shown that Larmor's statements of the non-existence of an influence of a translation on the rotation of the polarisation plane are erroneous, the disagreement arising from an error in Larmor's calculations. It is shown that the equations of both will become identical for $k = 0$. A. G.

1681. *Magnetic Rotatory Powers of Ring Compounds; Camphor, Limonene Carvene, Pinene and their Derivatives.* **W. H. Perkin, Sen.** (Chem. Soc., Journ. 81. and 82. pp. 292–318, April, 1902.)—Saturated closed chain or ring compounds—such as tri-, tetra-, penta- and hexa-methylene derivatives—have a much lower magnetic rotation than those having unsaturated open chains, but the same composition; their rotations are also smaller than those of the saturated open chain compounds, from which they differ in composition by H_2. On comparing the rotations of the mono- and di-carboxylic acids and ketones of the closed chain compounds with those of the corresponding saturated open chain aliphatic compounds, it is found that, if tri-, tetra-, penta- and hexa-methylene be taken as the first, second, third and fourth members of the series, and be compared with the corresponding members of the aliphatic series, the differences between the rotations of the two series are then nearly uniform, and amount to about —0·60 in the mono- and dicarboxylic acids, ketones and monochloro-derivatives of hexamethylene; in the ring hydrocarbons, this difference is, however, much larger, amounting to about 0·988. As regards the influence on the rotation of a double or bridged ring compound, in which the ring formation from the open chain compound has taken place twice, and hence with the loss of four hydrogen atoms, this, in the case of camphor, is —1·290, and in camphene, —1·387, these numbers being slightly greater than that for a single ring; borneol and pinene give similar results. For the limonenes, which are isomeric with camphene, but contain only a single unsaturated ring along with the group, $-C(CH_3):CH_2$, outside the ring, the rotations are very different, the value of the single ring formation, allowing for unsaturation, being practically the same as in hexamethylene, 0·988. The rotations of some other derivatives are also considered. T. H. P.

1682. *Rotatory Powers of the Esters of Stable Lævo-Borneol.* **J. Minguin** and **E. G. de Bollemont.** (Comptes Rendus, 134. pp. 608–610, March 10, 1902.)—The results are given of measurements of the specific rotatory powers of a number of bornyl esters prepared from the stable lævo-borneol. The transformation of the borneol into its formic ester is accompanied by a change in the $[\alpha]_D$ from —38·09 to —49; the absolute value of this magnitude then goes on gradually decreasing as the molecular weight of the ester increases. For the series, formate, acetate, propionate, butyrate, isobutyrate, valerate, and laurate of bornyl, it is found that the specific rotation is approximately inversely proportional to the molecular weight. The various haloid derivatives of those fatty esters examined also obey a similar law, but the product of specific rotation and molecular weight is not the same for the two series. T. H. P.

1683. *Radiation of Mercury in the Magnetic Field.* **C. Runge** and **F. Paschen.** (Astrophys. Journ. 15. pp. 235–251, May, 1902.)—This important paper consists chiefly of the numerical results of an investigation on the lines of the mercury spectrum, to trace the connection between the Zeeman effect of the magnetic field and the distribution of the lines in series. It was carried out on lines whose wave-length comes between 5,460 and 2,534. The observations support the conclusions of T. Preston [Nature, 59. 248 (1899)]. They show that at different field strengths the distances of separation of the components of a line remain in proportion, so that only the scale of the image increases with the field strength. This rule enables the authors to reduce all their measurements to the same field strength. An exception to this appears to occur in the case of a few fainter components of the stronger lines. This the authors attribute to satellites which lie very near to the lines under consideration without the magnetic field. It is further shown that the increase of the scale of separation, with rising field strength, is always in the same ratio for all lines of the spectrum. As far as the accuracy of the measures permits, lines of the same series (*i.e.*, lines which are represented by the same empirical formula of Kayser and Runge, or of Rydberg), exhibit the same separation due to the magnetic field, in the sense that, according to the scale of vibration numbers, the components of all the series lines have the same distances, and that corresponding components are also polarised in the same way. R. S. W.

1684. *Banded Spectra of Nitrogen.* **H. Deslandres.** (Comptes Rendus, 134. pp. 747–750, April 1, 1902.)—In previous papers the author has pointed out that the radiations of a group of bands belonging to one spectrum can be represented by a formula of the form $N = ef(n^2, p^2) \times m^2 + Bn^2 + \phi(p^2)$, where m, n, and p are successive whole numbers, B a constant, and f and ϕ characteristic functions of the particular substance. Cuthbertson [see Abstract No. 1517 (1902)] has published a table showing the distribution of forty bands in the first group in the positive band spectrum of nitrogen, in which he defines thirteen series. In this table, however, there are two exceptions, namely the bands with heads at 16,819 and 16,474. If, however, fifteen series be defined, then these two bands fall into line as well as two new, rather weak bands at 14,729 and 16,819, measured by Thalen. The author further points out that in Cuthbertson's table, not only do the horizontal intervals form an arithmetical progression with a difference of 30·319, but the vertical intervals also form an arithmetical progression with a difference of 29·363. The combination of these two series gives the arithmetical progression diagonally across the table with variable differences. It follows from this that in the above general formula the function $\phi(p^2)$ assumes for the first group of bands the simple form $D + Cp^2$, so that the 42 heads of bands can be represented by the expression—

$$N = 22785{\cdot}1 - \frac{30{\cdot}319}{8}(2n)^2 + \frac{29{\cdot}363}{8}(2p+1)^2.$$

A table of frequencies is given, showing the values observed and those calculated from the formula, with an extremely good agreement between the two. The distribution of the component rays of each band, or the function $f(n^2p^2) \times m^2$ still remains to be determined, about which little is known, owing to the difficulty of examining the bands under high dispersion. In the second and third groups the bands form a series, with exactly the same difference as is observed in the second series above, namely, 29·363. Similar series are to be observed in other banded spectra, *e.g.*, carbon, and the differences are characteristic constants appertaining to each individual substance.

E. C. C. B.

1685. *Spectra, Densities, and Melting-points of some Groups of Elements.* **H. Ramage.** (Roy. Soc., Proc. 70. pp. 1–27, May 12, 1902.)—Corresponding lines are selected from the spectra of certain groups of metals, and their oscillation frequencies plotted against the atomic masses of the elements, in one diagram, and in a second, against the squares of the atomic masses. The lines drawn through the corresponding points on the diagrams show well the fact that the metals may be classified into groups by their spectra. These lines also show certain breaks, *e.g.*, between sodium and potassium in the alkali group, and in other cases. It is noteworthy that a decided break occurs in the lines drawn through the nebulous series of the aluminium group, while for the sharp series the break is insignificant. The densities and melting-points of the same elements were plotted in a similar way, and from these diagrams interesting analogies are to be noted with the spectra diagrams, particularly in the case of the aluminium group, for the density and melting-point curves are analogous to the curves of the diffuse series of spectrum lines, so that all three would seem to have their origin in the same fundamental cause.

E. C. C. B.

1686. *Measurements of Certain Absorption Spectra.* **G. Laubenthal.** (Ann. d. Physik, 7. 4. pp. 851–861, April 8, 1902. Abstract from the Bonn Dissertation.)—Measurements were made in various ways of the bands in the absorption spectra of the lakes formed by alkannin and certain metallic salt solutions. The salts used were the chlorides of the alkali metals and the metals of the alkaline earths. The means of the measurements of the various bands are given, and it is pointed out that, in the case of each of the two groups studied, the bands shift towards the red with increasing atomic weights, and that the shifts are proportional, so that the ratio between the wave-lengths of the two bands of each spectrum is constant for each group of metals. [Although the author's conclusions are based on somewhat scanty data, they are materially strengthened by the facts given in Ramage's paper. (See preceding Abstract.) If the wave-lengths of the absorption bands are plotted against atomic weights in a similar way to Ramage's method, the curves have almost identical shapes with those given in Ramage's paper for the same groups of metals. The same break occurs between sodium and potassium, and probably a similar break in the beryllium to calcium curve, but Ramage does not include beryllium. This is extremely interesting, inasmuch as the absorption spectra are thus brought into line with the emission spectra, and also the densities and melting-points, as having their origin in the same fundamental cause.] E. C. C. B.

1687. *Discrepancy between Grating and Interference Measurements.* **L. Bell.** (Astrophys. Journ. 15. pp. 157–171, April, 1902.)—The paper consists of a discussion of the relative value of absolute wave-lengths as determined by the grating and by Michelson's method, there being, between the values for D_1, as obtained by the two methods, a difference of 0·19 tenth metre. After considering the great sources of error in measurements made with the grating, the author concludes that as a means of absolute measurement the grating is not to be compared with the interference method. At the same time he points out that Michelson's measurements should be independently repeated in order to show their practical limits of error, and also is of the opinion that in the present state of our knowledge no measurement can be trusted to within 0·01 tenth metre. Future work should, he says, be addressed to the questions of shifts of lines under pressure changes, and of the constancy of wave-length in the solar lines, following up Jewell's preliminary paper. [Astrophys. Journ. 3. 89 (1896).] E. C. C. B.

1688. *Multiple Transmission Fixed-arm Spectroscopes.* **W. Cassie.** (Phil. Mag. 3. pp. 449–457, April, 1902. Paper read before the Physical Society, Nov. 22, 1901.)—Four designs of the multiple transmission spectroscope are described, which are alike, in so far that they all have the telescope and collimator in the same vertical plane, with the former at a higher level than the latter, but differ in their arrangements of the prisms. In the first design two equal half-prisms are used which are silvered at the back. One of these half-prisms is placed just below the telescope lens and the other just above the collimating lens, and the light from the collimator thus falls upon the lower part of the first prism. Being at minimum deviation, the light is refracted and then normally reflected at the silvered face, and thus passes out of the prism. The prism is inclined at such an angle as to direct the emergent ray into the lower portion of the second half-prism, where the same process takes place; the light is thus reflected backwards and forwards until finally it passes over the top of the first prism into the telescope. The two half-prisms are mounted on revolving tables which are simultaneously turned by an endless screw, by which means various portions of the spectrum can be examined. In the second design the rays from the collimator pass through an ordinary 60° prism, and then fall normally upon a plane mirror which reflects them back through the prism normally on to a second mirror. By slightly inclining the mirrors, the beam of light in its passage backwards and forwards continually rises until it passes over the prism into the telescope. In the third form two half-prisms are again employed, and are set close together in the same horizontal plane, with their hypoteneuses facing one another, and their apices pointing towards the collimator. The beam from the collimator falls on the outer face of the first prism, and is there refracted, and then totally reflected out into the second prism, where it is first totally reflected, and then refracted back towards the collimator, parallel to its first path. By means of a right-angled prism, the ray is twice totally reflected and directed again into the first prism. The prisms are again so adjusted that after several cycles the rays pass over the refracting prisms into the telescope. The fourth design is described in an addendum, and consists of a single half-prism with a right-angle prism cemented to the back, with its edge at right angles to the refracting edge of the half-prism. The beam from the collimator passes between two right-angle prisms set near together, and then enters the half prism just below the centre; it is then totally reflected back again through the half-prism, and leaves it a little higher than it went in. By means of the two right-angled prisms by the collimator, the rays are again directed into the half-prism below their last entry, and thus, on again leaving the half-prism, they are higher than before. After several cycles, the rays pass under the combination prism into the telescope. The author considers the last to be the best instrument because of least light being lost by reflection, and because it possesses full resolving power. E. C. C. B.

1689. *The New Gas from Radium.* **E. Rutherford** and **Miss H. T. Brooks.** (Chem. News, 85. pp. 196–197, April 25, 1902. From Transactions of the Royal Society of Canada, Ser. 2. 7. p. 21.)—The greater part of this paper treats of investigations previously dealt with. [See Abstract No. 2110 (1901).] The authors observe that the emanation there referred to is most remarkable, as it not only continues for long intervals to be a source of radiation which is apparently similar to easily absorbed Röntgen rays, but it in some way manufactures from itself a positively charged substance, which travels to the negative electrode and becomes a source of secondary radio-activity. J. J. S.

REFERENCES.

1690. *Pressure of Heat and Light Radiation.* **E. F. Nichols** and **G. F. Hull.** (Phys. Rev. 13. pp. 307–320, Nov., 1901.)—A preliminary communication.

1691. *Astigmatic Refraction through a Sphere.* **L. Matthiessen.** (Ann. d. Physik, 7. 2. pp. 381–389, Feb., 1902.)—A mathematical treatment of the case of oblique incidence through a sphere, starting from Reusch's equations for conjugate points of a beam incident obliquely on a spherical surface. G. E. A.

1692. *Electrical and Optical Phenomena of Moving Bodies.* **H. A. Lorentz.** (Archives Néerlandaises, 7. pp. 64–80, 1902.)—This is a French translation from the Kong. Akad. Wetensch. Verslagen, Amsterdam, 1899. G. W. de T.

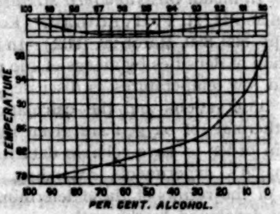
1693. *Radio-activity Imparted by Kathode Rays.* **J. C. McLennan.** (Phil. Mag. 3. pp. 195–203, Feb., 1902.)—A paper on the same lines as that dealt with in Abstract No. 42 (1902).

1694. *Optotechnics.* **S. P. Thompson.** (Soc. Arts, Journ. 50. pp. 518–527; Discussion, pp. 527–530, April 25, 1902.)—This is a paper outlining the essentials of optotechnical training, and advocating, in the interests of the British optical industry, the establishment of an optotechnical educational institute. G. W. de T.

HEAT.

1695. *A Thermoregulator.* **T. S. Patterson.** (Soc. Chem. Ind., Journ. 21. pp. 456–457; Discussion, p. 457, April 15, 1902.)—The author describes a modification of d'Arsonval's thermoregulator. The tube connected with the gas supply terminates just above a rubber drum stretched over the tube containing the supply of mercury or other expansible fluid. When the mercury expands, it causes the rubber drum to bulge out, and, wholly or partly, cut off the supply of gas. The mercury tube is connected with a side-tube containing a tap, to enable the amount of mercury in the apparatus to be regulated; the apparatus may therefore be adjusted for use at any part of the thermometric scale. D. H. J.

1696. *Boiling-point Curve for Mixtures of Ethyl Alcohol and Water.* **W. A. Noyes** and **R. R. Warfel.** (Chem. News, 85. pp. 185–186, April 18, 1902. From the Journ. Amer. Chem. Soc. 23. No. 7.)—According to Le Bel, 98 per cent. alcohol yields on fractionation a distillate of 97·4 per cent. strength by volume, and a residue of 99·5 per cent., implying that the boiling-point of absolute is higher than that of slightly diluted alcohol. To verify this, the authors have determined the boiling-points of a large number of mixtures, avoiding entrance of moisture during distillation by sealing the condenser to the side tube of H. C. Jones's apparatus, protected above by a calcium chloride bulb. Alcohol of a gravity indicating 99·98 per cent. was obtained by boiling twice with lime, adding the second time a little barium oxide. Several series of determinations were made, and the results calculated by interpolation for each half per cent., and plotted in the accompanying curve. The upper part gives the boiling-points between 90 and 100 per cent. on an enlarged scale; the lower portion is the complete curve. The minimum boiling-point occurs with alcohol of 96 per cent. by weight, while that of 90·7 per cent. has the same boiling-point as absolute alcohol. S. R.



1697. *Boyle's Law for Pressures of 75 and 150 mm. of Mercury.* **Rayleigh.** (Roy. Soc., Phil. Trans. 198. pp. 417–430, April 12, 1902. Roy. Soc., Proc. 69. p. 495, April 4, 1902 (Abstract).)—A special gauge was made by joining together two cylindrical glass chambers, one vertically above the other, by a short neck, cementing in this neck (and so completely blocking it) a glass rod, with its ends carefully pointed, and the upper one bent downwards so as to be 75 mm. from the other, connecting the bottoms of the chambers by a narrow tube C, continuing the upper chamber upward and the lower chamber downward by narrow tubes H, I, and connecting a narrow tube G to the top of the lower chamber. If then, by means of H, mercury is sucked up I, so as to fill C and touch both ends of the rod, the gas entering the lower chamber by G must be of higher pressure than that in H by 75 mm. of mercury. Two such gauges were employed which, as determined by testing them in parallel, indicated pressures in the ratio of 1 : 0·99862. A volume of gas was taken with the pressure indicated by one of these gauges, and it was then compressed till the pressure was that of the two in series, its new volume being noted: and it was found that, to an accuracy of $\frac{1}{5000}$, air, hydrogen, oxygen, and argon obey Boyle's law at the pressures and temperatures (10°–15° C.) of the experiments, while nitrous oxide deviates from it in having greater compressibility. R. E. B.

1698. *Atomic Weight and Specific Heat of Vanadium.* **C. Matignon** and **E. Monnet.** (Comptes Rendus, 134. pp. 542–545, March 3, 1902.)—The specific heat of vanadium has not been determined up to the present. The authors have rectified this omission by determining the specific heats of alloys of vanadium with aluminium and with iron, and thence deducing the specific heat of the vanadium alone by applying the law of Regnault to the alloys. The vanadium iron gave for vanadium the specific heat 0·1258, and the atomic heat 6·4, for temperatures between 15° and 100°; the vanadium-aluminium gave for the vanadium the specific heat 0·1235, and atomic heat 6·3. D. H. J.

1699. *Isothermals of Di-atomic Gases and their Mixtures. II., III., and IV.* **H. Kamerlingh Onnes** and **H. H. F. Hyndman.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 809–829, March 29, 1902.)—In the first of this series of papers the determination of densities by means of the piëzometer, in the case of variable volume and low temperatures, is discussed, full particulars being given with regard to observations and the calculation of results. In the second paper the isothermals of oxygen are given for the temperatures of 20·0°, 15·6° and 0° C., in order to have reliable data for pressures inferior to 100 atmospheres, Amagat's experiments extending only over very high pressures. By means of the results of these determinations, the coefficients for oxygen in the series developed by the authors in a preceding article can be corrected, and the corrections accounting for temperature differences may be effected, with values taken from the authors' own work. In the third article the compressibility of hydrogen at 0° and 20° is investigated with the piëzometer, for variable volumes and low temperatures, in order to test this method on Schalkwijk's results, this comparison being so satisfactory as to warrant the reliability of the determinations made for oxygen. A. G.

1700. *High Temperatures and the Law of Stefan.* **Féry.** (Comptes Rendus, 134. pp. 977–980, April 28, 1902.)—The principle of the apparatus here described is to place near the body whose (high) temperature is to be measured, another suitably chosen body, and from the temperature elevation of the latter due to radiation, calculate by Stefan's law the temperature of the former. The arrangement used consists of a lens to concentrate the heat rays, and a thermo-electric couple of iron and constantan connected up to a galvanometer. A comparison is made of results from this instrument in conjunction with Stefan's law, and results from a Le Chatelier pyrometer, for temperatures from 840° to 1,450°. The difference is in all cases less than 1 per cent. This method gives 3,490° as the temperature of the positive carbon of the electric arc. J. W. P.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1701. *Effect on Charged Condenser of Motion through the Ether.* **F. T. Trouton.** (Roy. Dublin Soc., Trans. 7. pp. 379–384, April, 1902.)—Fitzgerald, in 1900, suggested that a charged condenser moving through the ether with its plates edgeways to the direction of motion should possess a magnetic field between the plates, in consequence of the motion. If, therefore, the earth is moving through the ether, a condenser placed with its plates edgeways to the direction of the relative motion should, provided the energy required to establish this field be derived from the charging source, experience a drag during charge and a forward impulse during discharge. Preliminary experiments made by the author with a delicately suspended condenser during Fitzgerald's lifetime gave only negative results, and the latter expressed the opinion that, if these were confirmed, they were to be attributed to a diminution of the electrostatic energy of the condenser when in the edgewise position, due to the dimensional changes arising from the motion through the ether by which Lorentz and himself had explained the negative results obtained in the Michelson-Morley experiment. The author has since perfected the apparatus, using a condenser in which the drag-impulse would have a kinetic energy of about an erg, while, by timing the impulses so as to tend to set up a swing, an impulse of kinetic energy 0·004 erg would produce observable effects. No effect, however, could be detected. The author points out that, if the energy for the magnetic field when moving edgeways is supplied by the charging source, there must be a continuous turning movement tending to set the condenser flatways to the direction of motion relative to the ether. He proposes to experiment with a view of finding such an effect, and observes that such experiments would not be complicated by the relay arrangements which had to be employed to prevent sparking during the intermittent charging at the high p.d. of 1,200 volts which was employed.

G. W. DE T.

1702. *Crémieu's Experiments and Wilson's Objection.* **A. Potier** and **H. Poincaré.** (Écl. Électr. 31. pp. 83–93, April 19, 1902.)—Wilson has stated that Crémieu's results, instead of being contrary to the accepted theory, are really an indirect corroboration of it, as the effect of convection-currents should be opposed and balanced by that of conduction-currents in the screen separating the astatic apparatus from the rotating disc. In the present article there is published some correspondence on the Crémieu experiments, which passed between MM. Potier and Poincaré some time ago (December 4, 1900–January 13, 1901). In this correspondence the theoretical conditions of the problem are discussed, and the influence of the screen and of conduction-currents comes under consideration. Both writers are agreed that the effect of conduction-currents is *nil.* Considering the case of two circular metallic discs, D and D′, with an electrified mass M rotating between them—M inducing on D and D′ electric charges which rotate with it—Poincaré agrees that there is a strong conduction-current in the direction in which the disc rotates, but there is also, he says, a weak conduction-current right round the disc in the opposite direction. This current is weaker than the other, but it is longer; at each point of the disc it lasts longer than the strong current, so that there is a balance, and the mean current is zero. [See also Abstracts Nos. 1666 (1900), 144, 858, 1100, 1808, 2139 (1901).] W. C. H.

1703. *Duration of Charge and Deformation of Condensers.* **G. Ercolini.** (N. Cimento, 3. pp. 353–372, May, 1902.)—The deformation of condensers increases with the time of charge, except that in the first moments it remains constant, in general, for a time which is longer the greater the potential; the increase of deformation diminishes with the duration of the charge. Discharge does not restore a condenser to its original condition; the residual deformation increases when the potential, or the duration of the charge, increases. After a certain time, always short, the condenser returns to the original condition, passes it, and remains deformed for a long time, never less than, say, five minutes. Under potentials maintained constant, the deformations are less than those under rising potentials. During charge or discharge there is an exchange of heat energy between the condenser and its environment, and there is a change in the thermic capacity of the condenser, which diminishes as the difference of potential between its plates increases. These two phenomena tend to produce opposite variations of temperature. The slower the charging the more the condenser cools down. A. D.

1704. *Lightning Above and Below Water.* **J. Trowbridge.** (Scientific American, 86. p. 239, April 5, 1902.)—The author describes experiments which lead him to the conclusion that lightning never strikes the surface of the sea. When a lightning discharge seems to do so, it really passes from one region of the air to another, and it is only perspective which leads one to suppose that it strikes the water. The author has often endeavoured to pass powerful sparks to the surface of water, in order to obtain a strong spectrum of water vapour, but in every case the sparks—6 in. in length, and resembling lightning discharges as far as possible—refused to strike the level surface of the water and pass to the edges of the containing vessel. In a vacuum tube with water terminals and exhausted to the vapour tension of water, no discharge could be made to pass from one water-surface to the other. It is also very difficult to pass powerful sparks from one stream of water to another, and the author thinks it improbable that lightning discharges pass through regions in the air of heavy rainfall. In his endeavours to obtain a good water-vapour spectrum, the author set himself to produce an electric spark under water. Using distilled water, it was necessary to use platinum wires sealed in glass tubes, and emerging not more than half an inch. If the terminals are dipped to a depth of 2 in. in the water, the containing tube, if not more than 2 in. in diameter, is shattered by the sparks. If the terminals are only dipped to a small depth in the water, a spark passes giving a very brilliant light resembling that of an enclosed arc lamp, but having no lines in its spectrum. This spectrum is probably due to water vapour, and the different spectra of lightning obtained by different observers are due to different amounts of water vapour in the air. Zigzag lightning occurs in the lower regions of the atmosphere, certainly below 1,000 ft.; above 1,000 ft. it loses its zigzag character, and can be of great length with the same voltages as in lower altitudes. At still higher regions we have the aurora. Water vapour plays a controlling part in all these phases of lightning. W. C. H.

1705. *Annual Periodicity of Auroras.* **C. Nordmann.** (Comptes Rendus, 134. pp. 750–752, April 1, 1902.)—The author offers an explanation for the well-known fact that in the middle latitudes there is a double annual periodicity in the frequency of northern lights, the maximum occurring at the time of the equinoxes, and the minimum at that of the solstices. He does not enter upon a discussion of the causes to which the phenomenon of the aurora borealis is due, he merely takes for granted that the sun plays a part in its production, and that the shorter the time that the atmosphere has been deprived of the action of the solar rays, the greater is the intensity of the auroras. This is shown in their diurnal variations, by the fact that their greatest frequency coincides with the early evening hours. The same interdependence of the frequency of northern lights, and the saturation of the atmosphere by sunlight is perceptible in the annual periodicity. At the time of the equinoxes, that terrestrial great circle which divides day from night has a position perpendicular to the equator, *i.e.*, to the plane of the earth's rotation, while at the time of the solstices it has an inclination toward the latter of $90^\circ - 23^\circ 27' = 66^\circ 33'$. The isolated portion of the atmosphere, therefore, which during a given time t passes from day into night, *i.e.*, from one side of the dividing circle to the other, occupies alongside this circle an area, the width of which at the moment of the equinoxes is l, while at the moment of the solstices it is $l \times \sin 66^\circ 33' = l \times 0{\cdot}9$, l being the arc through which the earth rotates during the time t. Other things being equal, therefore, 10 auroras at the period of the equinoxes correspond to 9 at the solstices. This difference is rendered still greater by the twilight which reigns in a part of the atmosphere bordering on the dividing greatest circle and having a width equal to $\frac{l}{n}$. In this area the auroras are not yet visible, its illumination being still too bright, while at the same time the efficiency of the sun's rays in the production of auroras is no longer sufficiently great to be taken into account. If l therefore represents the width of the atmospheric area, counting from the dividing circle, in which the greater number of auroras occurs after sunset (the number of those occurring in atmospheric regions plunged into greater darkness compared with the latter is insignificant), the difference in the frequency of auroras at the two periods mentioned is represented by the formula $r = (l \times 0{\cdot}9 - l/n)/(l - l/n)$, which is smaller than $(l \times 0{\cdot}9)/l$. Assuming, for instance, that n equals N, we get $r = 0{\cdot}8$, which means that eight auroras at the periods of the solstices correspond to ten at the equinoxes, which agrees with the observed differences. Nevertheless this value is only approximately correct. To render it more accurate, the facts must be taken into account (1) that the number of auroras, counting from the moment of sunset, does not grow as fast as at the time counting from the same starting-point (*i.e.*, their number is greater during the first hour than during the next), and (2) that the time r, intervening between the moment of sunset and the end of twilight, is shorter at the period of the equinox than at that of the solstice. By so doing it will be seen that the value for r is still smaller than that given above, *i.e.*, that the difference in the frequency of auroras at the two periods stated is still greater than that above mentioned. G. G.

1706. *Electric Potential of the Atmosphere on Spitzbergen and Juist.* **J. Elster.** (Terrestrial Magnetism, 7. pp. 9–15, March, 1902.)—The observations made in Virgohafen on Spitzbergen in the summer of 1900, gave a low potential gradient and a high conductivity of the air (five times the average value for the Continent of Europe). On the island of Juist (near Borkum, the North Sea), the conductivity was found normal in summer, 1901, but the potential gradient very high, especially with winds from the sea. According to Lenard and Kelvin, the positive charge of the air is largely due to the salt-water spray produced by breakers; but the distance of the flame-collector from the breakers made no difference in Heligoland, where the experiments were continued under more convenient conditions. H. B.

DISCHARGE AND OSCILLATIONS.

1707. *Rise of Pressure on Breaking a Circuit with Capacity.* **C. C. Garrard.** (Elect. Rev. 50. p. 572, April 4, 1902.)—A quarter-mile length of high-tension, lead-covered, 7/20 concentric cable was connected, between the inner and outer, with a 4,000-volt supply, a horn arcing-switch, and a Ferranti oil-switch. At the other end of the cable a spark-gap was connected between the inner and outer conductors, which was set so as just not to spark over with the normal pressure. When the capacity current was broken with the arcing switch, the air-gap invariably sparked over, but when broken by the oil-switch, where practically no arc was formed, no spark passed. The author concludes that a non-arcing switch is of advantage in preventing rise of pressure in the circuit. G. H. B.

1708. *The Recombination of Ions in Gases.* **P. Langevin.** (Comptes Rendus, 134. pp. 533–536, March 3, 1902.)—The author has already indicated the principle of the method by which he has directly measured the ratio $\epsilon = \frac{\alpha}{4\pi(k_1 + k_2)}$, where α represents the coefficient of recombination of the ions, k_1 and k_2 the mobilities of these ions in an electric field. [See Abstract No. 1558 (1902).] The ratio of the number of recombinations to the number of collisions between ions of contrary signs is also represented by ϵ, which must, therefore, always be less than unity. The experimental method consists in creating a uniform field in the gas contained between two parallel metallic laminæ and determining: (1) The quantity of electricity σ induced on one of these laminæ at the instant of the formation of the field; (2) the quantity of electricity Q collected by this lamina after the passage into the gas of the Röntgen rays proceeding from *a single discharge* in a Crookes' tube; (3) the quantity of electricity Q_0 liberated in the gas by the radiation, and that would be collected in an infinite field; the difference between Q and Q_0 being due to the recombination of the ions.

Theory indicates the following relation between these quantities, independent of the initial distribution of the ionisation in the gas—

$$\frac{\epsilon Q}{\sigma} = \log\left(1 + \frac{\epsilon Q_0}{\sigma}\right).$$

The quantity Q_0 not being obtainable directly was obtained from the measurement of the quantities Q and Q′ collected in two different fields produced by the charges σ and $\sigma' = m\sigma$. Details of the experimental arrangement are given, and although the thickness of the layer of gas, the field, and the distribution and intensity of the ionisation were caused to vary within wide limits, the values obtained for ϵ in dry air under atmospheric pressure at 17° remained between 0·26 and 0·28. The mean value 0·27 coincides with that which may be deduced from Townsend's determination of the coefficient of recombination α obtained by an entirely different method. There is thus in air at

normal pressure about one recombination in four collisions between ions of contrary signs. The ratio ϵ tends towards unity when the pressure increases.
J. J. S.

1709. *The Mobility of the Ions in Gases.* **P. Langevin.** (Comptes Rendus, 134. pp. 646–649, March 17, 1902.)—The author explains how his method, described in a previous paper [see preceding Abstract], may be employed to measure the mobility of ions more directly and in more varied conditions than has been possible hitherto. This is due to the extremely short duration (about 10^{-4} seconds) of the single discharge of a coil through a Crookes' tube which is used in the experimental method. This method is further discussed in the paper, and the results obtained for different gases under different pressures are promised in a later communication.
J. J. S.

1710. *An Induced Property of Ionised Air.* **F. Campanile** and **G. di Ciommo.** (Elettricista, Rome, 11. pp. 69–71, March, 1902.)—The authors have investigated the discharging effect of ionised air which has passed over the surface of a volatile liquid, as compared with that of the same ionised air after passing over a non-volatile liquid like glycerine. The ionised air in each case was made to impinge on the knob of a charged gold-leaf electroscope, which was observed during the experiment. The results are given in the following table:—

Experimental Liquids.	Length of Time for Discharge.	
	Positive Charge.	Negative Charge.
Glycerine	121·5″	133·5″
Alcohol	88·0″	97·0″
Glycerine	121·5″	129·7″
Water	107·0″	112·0″
Glycerine	109·0″	109·0″
Benzene	90·0″	95·0″
Glycerine	185·8″ (?)	149·6″
Chloroform	101·0″	109·0″
Glycerine	105·7″	113·0″
Carbon bisulphide	88·5″	92·0″
Glycerine	132·0″	111·5″
Turpentine	97·0″	81·0″
Glycerine	370·0″	285·0″
Petroleum	330·0″	243·0″

It is seen that the discharging effect of the ionised air is increased by the vapour of the volatile liquid. We may explain this increase (1) by assuming that the mingled vapour has a greater conductivity than the ionised air, or (2) by assuming that the mingled vapour is ionised.
D. H. J.

1711. *Variation of the Spectrum of Sparks.* **B. Eginitis.** (Comptes Rendus, 134. pp. 824–825, April 14, 1902.)—When the spark terminals contain different metals, variation of the self-induction of the circuit greatly affects the composition of the light given by the spark. Using terminals of aluminium wire coated at their ends with a small quantity of metallic sodium, the author finds that the spectrum of ordinary sparks passing between the terminals contains aluminium and sodium lines, but that when the self-induction of the circuit is increased, while keeping the resistance constant, the aluminium rays diminish very rapidly in intensity, while the yellow sodium rays become more and more intense. The aluminium rays are confined more and more to the neighbourhood of the terminals, and finally, when the self-induction is sufficiently increased, disappear altogether. The sparks are then of a brilliant orange colour, due to sodium vapour, and if the self-induction is still further increased, there comes a point at which the sodium line is reversed, aluminium being still absent from the spectrum. The same results are obtained with platinum, iron, tin, and some other metals, in place of aluminium. In some cases, *e.g.*, iron-sodium, the large values of self-induction make the iron rays reappear. Some metals, *e.g.*, Hg, K, or Na, can never be wholly eliminated from the spectrum. The peculiar behaviour of mercury leads the author to the general conclusion that the metals whose spectra are eliminated or diminished in intensity are metals which give small quantities of vapour, while those whose spectra persist or increase in intensity are among the very volatile metals. W. C. H.

1712. *Spark Discharge from Metallic Poles in Water.* **N. Lockyer.** (Astrophys. Journ. 15. pp. 190–198, April, 1902.)—Experiments were undertaken to test Wilsing's hypothesis that other causes, such as pressure, rather than motion in the line of sight, are the origin of the displacement and the doubling of the lines observed in the spectra of new stars. The discharge was produced by means of the Spottiswoode 42 in. spark coil with a condenser in the secondary circuit, so that the spark-length in water was about 0·5 mm. Although the photographs of the spectra of magnesium, iron, and zinc show reversals and shifts of position producing effects similar in appearance to the photographs of the spectra of new stars, the author concludes that the pairs of bright and dark lines in the latter cases are not due to the same cause as are the effects observed with the spark in water. This conclusion is based on the following reasons: while in the first place, in the case of the spark in water, the absorption lines are least and the emission lines most shifted, and in the new stars the opposite is the case, in the second place the shifts are very different in degree, being, for the absorption lines, in the one case small and in the other enormous. [See also Abstract No. 1539 (1902).] E. C. C. B.

1713. *Electric Oscillations in Distributing Networks.* **J. B. Pomey.** (Comptes Rendus, 134. pp. 696–697, March 24, 1902.)—In a network, oscillations could only occur through exchange of electric energy of condensers and magnetic energy of bobbins; but this is impossible. The strength of current takes the form $\Sigma C\epsilon^{\lambda\tau}$ where λ is negative, and there are no oscillations. A. D.

1714. *Duddell's Musical Arc.* **P. Janet.** (Comptes Rendus, 134. pp. 821–823, April 14, 1902.)—Let E be the e.m.f. of the battery of accumulators working the arc, R the resistance of the rheostat (without self-induction) in the main circuit, r the resistance of the derived circuit, L and C the self-inductance and capacity in this circuit, then $\omega = 2\pi \times \text{frequency} = 1/\sqrt{CL}$. Let I be the instantaneous value of the current in the main circuit, i that of the current in the derived circuit, and i^1 in the arc. The main current I is evidently the superposition of a continuous current and an alternating current, whence $I = I_c + I_o \sin \omega t$. The potential difference at the terminals of the arc $V_A - V_B = E - RI_c - RI_o \sin \omega t$, also $i = \frac{R}{r} I_o \sin \omega t$, $i^1 = I_c + \frac{R+r}{r} I_o \sin \omega t$. Hence $d(V_A - V_B) = -RI_o\omega \cos \omega t dt$ and $di^1 = \frac{R+r}{r} I_o\omega \cos \omega t dt$. Therefore $d(V_A - V_B)/di^1 = -Rr/(R+r)$; consequently the differential coefficient of the potential difference at the terminals of the arc with respect to the current in the arc should be negative; this is the case with homogeneous carbons, even for oscillations of frequency from 1,000 to 10,000 per second. When r is small in comparison to R, $d(V_A - V_B)/di^1 = r$ numerically, that is to say, the apparent resistance of the arc should be numerically equal to that of the derived circuit. The paper then gives a table of the values of the instantaneous, effective, and mean currents, and the distribution of power in the different parts of the circuit. [See also Abstract No. 1098 (1902).] E. C. R.

1715. *Inductive Circuit with Harmonically-varying Resistance.* **T. Mizuno.** (Electrician, 49. p. 222, May 30, 1902.)—The author obtains an expression for the current in an inductive circuit whose inductance is constant, but whose resistance consists of a constant term and a harmonically varying one; the impressed e.m.f. is assumed to be constant. If the variation in the resistance is small and the frequency high, the circuit is almost indifferent to harmonic variation of the resistance. A. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1716. *Graduation of Thermo-electric Couples.* **D. Berthelot.** (Comptes Rendus, 134. pp. 983–985, April 28, 1902.)—Comparing the couples used for high temperatures, viz., platinum-palladium (Becquerel), platinum-platinum iridium (Tait, Barus), platinum-platinum rhodium (Le Chatélier), the author prefers the second, which is less costly, not less exact, and a little more sensitive than the others. A straight line law holds for the relationship between the logarithms of the electro-motive force and of the Centigrade temperature, the cold junction being at 0° C. and the range being 400° to 1,100°. For graduation it is therefore only necessary to find two fixed points, and if the range is to be 400° to 1,100°, the melting-points of zinc (419°) and of gold (1,064°) are recommended. Tables of figures showing agreement of directly observed results and those calculated from the graduation on the principles described, are given for a variety of temperatures. With a good galvanometer one should obtain without difficulty a sensibility of 0·1° in the vicinity of 1,000°. J. W. P.

1717. *The Induction Coil.* **J. Trowbridge.** (Phil. Mag. 3. pp. 393–396, April, 1902.)—The author finds that the performance of a powerful induction coil by Heinze, with a Heinze liquid interrupter, confirms Rayleigh's conclusions. [See Abstract No. 879 (1902).] The length of the iron of the primary coil is 48 in., its diameter 3¼ in., and it is wound with one layer of No. 6 copper wire. The secondary coil consists of 140 sections of between 400 and 500 turns of fine wire separated by ⅛ in. glass plates, and having a total resistance of 246,600 ohms. They are not embedded in paraffin, so that any section can be replaced if damaged. When excited with five accumulator cells a 15-in. spark is obtained with a condenser in the primary and an ordinary vibrating break, and a 30 in. one, of astonishing body, with the liquid interrupter and no condenser. The number of interruptions per minute can be varied from 60 to 5,000 by varying the speed of the motor which operates it. G. W. DE T.

1718. *A Self-recording Atmospheric Electroscope.* **G. le Cadet.** (Comptes Rendus, 134. pp. 745–747, April 1, 1902.)—With a view to electric measurements in conjunction with Janssen this summer, on the summit of Mont Blanc, the author has devised a self-registering electroscope, provided with a collector which is free from the objections that apply to water dropping, flame, and other usual collectors. The analogy which Elster and Geitel have shown to exist between the actions on gases, of flame, phosphorus, Röntgen and Becquerel rays, led the author to use a radio-active substance (a chloride of barium and radium) for the collector. The radium compound is placed in a closed rectangular box of aluminium, 5 cm. × 1·5 cm., placed at the end of an insulated brass rod, 2 m. long; such a box is transparent to Becquerel radiations, and may be used in wind and rain without detriment to its efficiency. The collector is attached to a calibrated electroscope or electrometer. By means of a beam of light passing through a very narrow slit, an image of the leaves of the electroscope is thrown on a horizontal photographic drum. D. H. J.

1719. *Ammeters and Voltmeters compensated for Variations in their Field.* **P. Weiss.** (Soc. Int. Élect., Bull. 2. pp. 266–275; Discussion, pp. 275–276, April, 1902.)—The paper describes the instruments constructed by Japy Frères & Cie, on the principle invented by the author [see Abstract No. 1525 (1901)], in which the controlling force of a d'Arsonval system is given by a small piece of soft iron, instead of by a spring, the controlling force thus varying with the strength of the permanent magnet. If the soft iron piece were always magnetised longitudinally, even when deflected, the curve between the strength of field and the current would be the curve of magnetisation of the soft iron; the actual curve deviates somewhat, as the direction of magnetisation of the soft iron does not turn exactly with the iron. The corresponding curve for a spring control proportional to the deflection is a rectangular hyperbola, and by combining the two controls, the current required to give a certain deflection can be made practically independent of the field. The instruments are constructed after the pattern of the Weston type with a silver spiral spring. A change in the magnet strength of from 570 to 670 makes less than 1 per cent. difference in the lower parts of the scale, and leaves the higher practically unaltered. On account of the small action of the control springs, the instruments are practically unaffected by variations in elasticity and by variations in temperature. The voltmeters are wound with manganin, and the deciamperemeters, which are used with shunts as ammeters, have a resistance of 1 ohm, of which half is of manganin. In reply to a question by **Arnoux**, the author stated that there was no difference in reading on an ascending and a descending curve. G. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1720. *Harmonic Analysis of Waves by the Ondograph.* **E. Hospitalier.** (Ind. Élect. 11. pp. 150–153, April 10, 1902.)—The following simple methods of detecting the presence of harmonics in an alternating-current wave by means of the ondograph [see Abstract No. 2172 (1901)], and of analysing the curve into its components are given. We can either use a large condenser (C), and trace its charging current by an ondograph, when the high harmonics will be shown magnified, and the current wave will present a very jagged appearance, or we can put a very large non-inductive resistance in series with an inductive coil, and apply the ondograph across the inductive coil, obtaining a curve which will show any high harmonics considerably magnified. The author then applies Pupin's Resonance method [see Abstract No. 1369 (1902)], and shows how, with the help of the ondograph, we can determine the magnitude and the phase of the various harmonics which form the actual wave. A. R.

1721. *Conductivity and Magnetic Properties of Iron Alloys.* **W. F. Barrett, W. Brown,** and **R. A. Hadfield.** (Inst. Elect. Engin., Journ. 31. pp. 674–721; Discussion, pp. 721–732, April, 1902.)—This is a very comprehensive research on some 110 alloys. The alloying elements are carbon, manganese, nickel, tungsten, aluminium, silicon, chromium, copper. The alloys are grouped in three classes according as they contain one, two, or three elements alloying with iron. The alloys were prepared at the Hecla Iron Works by Hadfield, and in every case a careful chemical analysis is given in the tables. The paper is divided into four parts. I. *Electric conductivity.*—This was taken for all the alloys. The highest electric resistivity of any known metallic wires is in some of these alloys. Thus, 70 per cent. iron, 25 per cent. nickel, 5 per cent. manganese has resistivity 97·5 microhms (copper in 1·626). The following notes summarise such results as are new :—(*a*) The conductivity of iron is always reduced by alloying, even when the alloying element itself conducts better than iron ; (*b*) the greatest reduction of conductivity is always produced by the first increment of the element added ; (*c*) increase in resistivity according to the element used, follows the same order as increase in specific heat of the elements ; (*d*) annealing always diminishes the resistivity ; in one case quoted the diminution was 44 per cent. II. *Magnetic properties.*—Using a magneto-metric method, B.-H. cycles were taken for most of the alloys. The tables show at a glance the effect on the permeability of increasing the percentage of the elements. The effects of annealing are in some cases remarkable. Thus, a specimen 88 per cent. iron, 9 per cent. chromium, 3 per cent. manganese, gives (1) when unannealed, induction 500, (2) when annealed, induction 13,000, for the same field. III. *Non-magnetic alloys.*—By trial, various alloys have been made having susceptibility in some cases 0, in others only $\frac{1}{1000}$th of that of iron. Yet the proportion of iron in no case is less than 70 per cent. In some cases annealing causes the susceptibility to be increased five times or more. IV. *Alloys more magnetic than the purest commercial iron.*—There are two alloys—(1) 2¼ per cent. aluminium, the rest iron. This is nearly twice as permeable as pure iron for small fields (up to 2 c.g.s.). Its permeability remains greater up to the highest field tried (64 c.g.s.), though the ratio of the two permeabilities decreases steadily as H rises. (2) 2½ per cent. silicon, the rest iron. This is less permeable than the aluminium alloy, though much more so than iron for small fields. But for values of H more than 8 c.g.s. its permeability is surpassed by that of iron. In the discussion on the above paper remarks were made by **Kelvin, R. T. Glazebrook, W. M. Mordey,** and others with reference to hysteresis, "ageing" of iron, and various other practical applications of this research. [See also Abstract No. 1679 (1900)]. P. E. S.

1722. *Magnetic Observations in China during the Solar Eclipse,* Nov. 11, 1901. **J. de Moidrey.** (Terrestrial Magnetism, **7.** pp. 23–25, March, 1902.)—The eclipse was partial at Zi-ka-Wei in China. The observations, not throughout by the same observers, continued for ten hours, commencing about noon, two hours before the eclipse, and ending one and a half hours after it. The magnetic elements were not affected by the eclipse. H. B.

1723. *Determination of the Value of the Earth's Magnetic Field in International Units, and Comparison with the Values given by the Kew Magnetometers.* **W. Watson.** (Roy. Soc., Phil. Trans. **198.** pp. 431–462, May 2, 1902. Roy. Soc., Proc. **69.** p. 1, Nov. 8, 1901. (Abstract).)—The author undertook these measurements in view of the discrepancies found to exist between the values of H as measured in the various British observatories. The method adopted was to compare H with the field produced by a known current in a coil of known dimensions. The Helmholtz arrangement was adopted of two parallel coils at a distance from each other equal to the radius of either. The coils were mounted on a horizontal circle so that they could be turned about a vertical axis till the magnetic axis of the needle at the centre of the coils was at right angles to the axis of the coils when the current was passing. Then $H = CF/\sin\theta$, where C is the current through the coils, F the field at their centre due to it, and θ the angle through which they are turned. The current was measured by a silver voltameter, and also by a standard cadmium cell and standard resistance. The construction of the coils and magnetic system, and the precautions taken in measuring them, are fully described in the paper. The coil constants were checked by employing different methods of measurement, and F was determined with an accuracy of within one part in 6,000. The current employed was 0·05 ampere, and was not measured directly by the silver voltameter, but by a standard cadmium cell and two standard manganin resistance coils in series. The galvanometer and adjustable resistance used enabled the current to be kept constant to within one part in 120,000. In comparing the standard cells with the silver voltameter, the two resistance coils were placed in parallel, and a current of 0·2 amperes used. Both Clark and cadmium cells were prepared. The former showed differences amounting to four parts in 10,000, even after standing in an ice bath for two weeks, while the latter agreed to within one part in 15,000. The cadmium cells were therefore alone employed. The various determinations made of the electro-chemical equivalent of silver are discussed at length, and the author favours Kahle's measurements, taking the most probable equivalent to be 0·0011183 for a deposit from a fresh solution on a platinum surface. In making measurements two forms of voltameter were connected in series, Rayleigh's form and the form with a porous pot recommended by Richards, Collins, and Heimrod. The latter gives values of the equivalent 0·082 per cent. lower, and the author finds the results obtained from it slightly more concordant than those from Rayleigh's form, but does not credit it with much advantage. A full table of the results is given, from which it appears that, taking the electro-chemical equivalent of silver as 0·0011180, the value of H determined by the Kew instruments is 0·000007 c.g.s. units lower than that determined by the author's apparatus in international units. To compare the results with the determinations made of the e.m.f. of standard cells, a new set of cadmium cells was prepared, with an amalgam containing 12·7 per cent. of cadmium instead of 14 per cent. as in the old cells. The two sets of cadmium cells and the Clark cells were compared, and gave the following results as the e.m.f. of the old cadmium cells at 20 deg. in international volts, and taking the equivalent of silver to be 0·0011180.

From silver depositions	1·01909
From Kahle's value for cadmium cells ...	1·01855
From the Clark cells	1·01898
Mean	1·01888

Taking this mean value, which uses all the available data, the value of H given by the Kew instruments is 0·00002 c.g.s. units higher than the value in international units, and taking the electro-chemical equivalent of silver to be 0·0011183, and deriving the values from the silver depositions only, the value of H is 0·00004 c.g.s. units higher. G. H. B.

1724. *Magnetic Observations in North America during the Total Solar Eclipse*, May 17–18, 1901. **L. A. Bauer.** (Terrestrial Magnetism, 7. pp. 16–22, March, 1902.)—Reproduction of the special instructions sent to the observers of the U.S. Coast and Geodetic Survey at seven stations, from Sitka in Alaska down to Vieques on Porto Rico, comprising also the two magnetic observatories at Baldwin in Kansas and at Cheltenham in Maryland, and further to the five volunteer stations, including Toronto and El Contadero in Mexico. The entire interval of nine hours fell during night-time, but it was insisted that there should be no change of observers, and further that everything should be in thorough working order two days before the eclipse. At Cheltenham the Eschenhagen magnetograph proved superior to the old Adie form, and the D eye readings, made with the ordinary field magnetometers, as good as the best magnetograph work. The results obtained will be included in the general *résumé* of the international observations. H. B.

1725. *Experiments on Earth Currents.* **E. Jahr.** (Elektrotechn. Zeitschr. 23. pp. 195–197, March 6, 1902.)—Pairs of electrodes of the same or different materials, various metals and carbon or coke, or iron pipes, are buried in the ground or water near Berlin and connected by an insulated copper wire resting on china insulators above ground; the connecting wire, up to 1 km. in length, lies in the magnetic meridian. Weak currents are observed, the best results being obtained when the northern electrode is sunk to a lower level than the southern (magnetic inclination angle); the potential difference and current intensity are stated to be constant when this arrangement is adopted. With multiple earth batteries currents of 2 volts and 2·5 amperes have been observed. The experiments have extended over two years. H. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1726. *Electric Shocks.* **F. B. Aspinall.** (Inst. Elect. Engin., Journ. 31. pp. 748–761; Discussion, pp. 773–774 and 777–822, April, 1902. [See Abstract No. 1728 (1902)].)—The author commences his paper with a list of nine questions; the paper is divided into sections constituting the answers to these questions: (1) Is every one equally susceptible to an electric shock? The author's opinion is that not only are different people differently affected, but that the same person under different conditions does not feel the same. (2) Is a person suffering from disease more likely to be fatally injured by an electric shock than a person in good health? The author mentions the case of two persons of weak intellect who could stand abnormally strong shocks, and one of a man suffering from kidney disease who was so sensitive as to feel the pressure of three Leclanché cells. (3) Does the physiological condition one is in at the time a shock is received make any difference? The case is quoted of a man who received a shock of 2,000 volts between head and buttocks without being killed; he was in a heavy perspiration, which, the author suggests, shunted the current. Another man took 2,000 volts between his hands when drunk, and was not killed. When asleep the shock from a magneto-machine is not felt, and a man received a 5,000-volt shock without being killed. (4) Does the path which the current takes through the body have any effect as regards the shock proving fatal? The author quotes cases tending to show that the path taken is a most important factor. (5) Does the question of contact made, and whether burning takes place or not, have any effect on a person's chance of being killed? The author considers the question of contact most important; with a small or bad contact not only is the resistance greatly increased, but the tendency to burn is increased, and burning seems to afford great protection. Cases are quoted to support this view. (6) Can a person receive a fatal shock without giving the cry, and also can he speak after receiving a fatal shock? The author answers both questions in the affirmative. (7) Is an alternating or a direct-current shock more likely to prove fatal? If contact be made with metal of such a shape that it cannot be gripped and the current passes from hand to hand the direct current seems to knock the victim down, whilst an alternating current seems to draw him closer. On the other hand, if he can grip the metal the direct current holds him tighter. The direct current burns more than the alternating, and the author finds the after-effect of a direct-current shock to be worse. He does not think, though, that one system is more dangerous than the other. (8) Cannot the medical profession give us a more certain method of ascertaining whether a man is dead or not? It is recommended to ascertain if the sphincter muscle is relaxed, but this is objectionable and difficult to judge to a non-medical man. (9) Cannot something more be done to help those who receive a shock? The author suggests that the same treatment should be applied as is used for collapse from chloroform, namely, to hold the body head downwards for a few seconds to flush the brain before applying artificial respiration. G. H. B.

1727. *Electric Shocks at Five Hundred Volts.* **A. P. Trotter.** (Inst. Elect. Engin., Journ. 31. pp. 762–773; Discussion, pp. 773–774 and 777–822, April, 1902. [See Abstract No. 1728 (1902)].)—The paper is divided into three parts: (1) *Physiological and Electrical Conditions.*—The sensation does not depend directly on the actual current but on the current density. With 4 or 5 sq. in. of contact, a current of 1 to 2 milliamperes is hardly perceptible, and one of 10 is painful; with larger currents muscular contractions are caused, especially if the current be unsteady. From boot to boot, where the contact is large, 35 milliamperes is less painful than 14 between the finger-tips, where the contact is small. The resistance from boot to boot, the boots being dry and without nails, varies from 45,000 to over 200,000 ohms. (2) *Dangers connected with trolley wires.*—There is no danger in grasping a trolley wire when standing in the street or on a car. With worn boots and after walking 2 miles on wet pavements, the author stood on a rail and grasped a trolley wire; the current was 35 milliamperes and the sensation was endurable for a few seconds; there was no after-effect. (3) *Dangers connected with third rails.*—Even with damp boots there is no unpleasant shock on stepping on a third rail at 500 volts. On touching the rail with the finger, a smart shock is felt. A serious shock can occur only by making contact with both running and third rails with the bare skin, and by maintaining the contact for some time. G. H. B.

1728. *Electric Shocks. Discussion on Papers by* **C. E. Webber. F. B. Aspinall,** and **A. P. Trotter.** [See Abstracts Nos. 1730, 1726, and 1727 (1902).] (Inst. Elect. Engin., Journ. 31. pp. 773–774 and 777–822, April, 1902.)—**A. P. Trotter** tabulated the results of his tests of the sensations felt and the currents taken by different members of the Institution at pressures of 100 and 500 volts. **W. S. Hedley** did not agree with Webber's views of the physiological action of the current. He considers the effect to be fibrillar contraction of the heart; when the heart is exposed, a much weaker current applied to it will kill than when the current is passed through the skin. The path of the current is of great consequence. High-pressure currents may kill in a different way by preventing respiration. Where syncope is produced, he favours Aspinall's suggestion that lowering the head may be beneficial. **T. M. Legge** remarks that post-mortem examinations invariably show symptoms of asphyxia, and considers it important to decide whether death is due (1) to failure of respiration followed by failure of the heart; (2) to failure of the heart followed by failure of respiration; (3) to direct action of the current on the heart; or (4) to contraction of the arteries and capillaries. He refers to Prévost and Baccelli's experiments, and agrees with them that with high-pressure alternating currents on dogs, arrest of respiration is the first thing, but that with low tension of 170 volts or less, there is no effect on respiration, but the heart is thrown into a condition of fibrillary contraction for which artificial respiration is useless. **L. Jones,** in discussing Aspinall's paper, agrees with him that the effect of a shock depends very largely on the health and on the physiological condition of the victim. He is not able to give a certain method of ascertaining whether a man is dead or not. He agrees that inverting the victim and blows over the heart may be of use, and advocates rhythmic traction on the tongue to accompany artificial respiration. **M. B. Field** does not quite agree with Trotter that a trolley wire is not a source of danger. With one hand grasping an earthed handrail, the trolley wire may be flicked without danger, but if grasped it may be impossible to let go, and therein lies the danger. A momentary shock may not be dangerous, but a prolonged one of equal intensity may be fatal. The author then refers to the danger that may arise on high-pressure alternating systems from capacity currents. For the treatment of those rendered unconscious from shock he recommends the hypodermic injection of ether or brandy, to stimulate the action of the heart. **L. W. de Grave** gives a table of the sequence of sensations felt on taking shocks at different pressures for twenty minutes. G. H. B.

REFERENCES.

1729. *The Electron Theory of Metals.* **P. Drude.** (Ann. d. Physik, 7. 3. pp. 687–692, March, 1902.)—The author here makes corrections rendered necessary by an error in the sign of the Thomson effect in previous papers. [See Abstracts Nos. 1276 (1900) and 840 (1901).] A. D.

1730. *Electric Shocks.* **C. E. Webber.** (Inst. Elect. Engin., Journ. 31. pp. 732–747; Discussion, pp, 773–774 and 777–822, April, 1902.) [See Abstract No. 1728, (1900).]—The author deals first with the physiological effect of shock, and describes the results obtained by numerous experimenters. He next gives a *résumé* of the legislation for minimising the danger of shock to employés. G. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1731. *Action of Hydrogen Dioxide on Potassium Metavanadate.* **L. Pissarjewsky.** (Zeitschr. Phys. Chem. 40. pp. 368–371, March 29, 1902.)—Data are given for the heat of solution of KVO_3 and KVO_4 in water, and for the heat evolved by different molecular proportions of hydrogen dioxide when acting on KVO_3. It is found in the last case that the heat of reaction reaches a maximum when we have added two molecular proportions of H_2O_2, to one of KVO_3 and that further addition of hydrogen dioxide does not alter the heat-evolution. From this we may conclude that in addition to the compound KVO_4, obtained by the action of *one* molecule of the oxidising agent, there is formed a further well-defined compound by the action of *two* molecules. D. H. J.

1732. *Action of Hydrogen on Sulphides and Selenides.* **H. Pélabon.** (Annal. Chim. Phys. 25. pp. 365–432, March, 1902.)—The paper deals exhaustively with the equilibria obtained by the action of hydrogen on the sulphides and selenides of silver, mercury, arsenic, antimony, and bismuth, and by the action of sulphuretted or seleniuretted hydrogen on the corresponding metals. The method of experiment consists in heating the constituents in a sealed tube at the desired temperature until equilibrium is attained, and then determining the composition of the gaseous phase by rapidly cooling the system to a temperature at which the speed of reaction is negligible. The results obtained are found to agree with the thermodynamical equations of equilibrium, but the author appears to be ignorant of the phase-rule. F. G. D.

1733. *Chemical Dynamics of Nickel Carbonyl.* **A. Mittasch.** (Zeitschr. Phys. Chem. 40. pp. 1–83, March 18, 1902.)—The following is a summary of the results obtained. (1) Equilibria between nickel, carbon monoxide, and nickel carbonyl can be obtained from either side. (2) Increase of pressure favours the formation of the carbonyl. The dependence of the equilibrium on pressure obeys the theoretical equation, $K = \frac{C^4_{CO}}{C_{NiCO_4}}$. (3) The equilibrium varies with the particular form of nickel—strip, amalgam, or powder—employed. (4) The equilibrium varies with the temperature, and in accordance with the positive heat of formation, dissociation of the carbonyl increases with rise of temperature. (5) The decomposition of the carbonyl is a reaction of the 1st order; its formation, constant nickel surface supposed, a reaction of the 2nd order. F. G. D.

1734. *Composition of Gas Hydrates.* **de Forcrand.** (Comptes Rendus, 134. pp. 835–838, April 14, 1902.)—The formula, $\frac{Q}{T'} = 30$, recently shown by the author to hold for the dissociation of gas hydrates, can be applied for the purpose of determining the composition of these substances. Q = heat of formation of solid hydrate from gas and *ice*, T' = temperature (absolute) for which the dissociation pressure of the hydrate equals 760 mm. If Q' = heat of formation of hydrate from gas and *water*, then $Q' = Q + n \times 1430$, if there are *n* molecules of water for one of gas in the hydrate. Q′ can be measured directly or calculated by Clapeyron's formula from the dissociation curve, and Q is obtained from the equation $Q = 30T'$, where T′ can be measured directly. Hence *n* can be calculated. If T′ cannot be conveniently measured, it may be calculated by an application of Clapeyron's formula, provided Q′ is known. The author also gives an alternative method of calculation, and promises applications of the method in a future paper. [See also Abstract No. 854 (1902).] F. G. D.

1735. *Action of Hydrogen on Strontium Amalgam.* **Guntz.** (Comptes Rendus, 134. pp. 838–840, April 14, 1902.)—When strontium amalgam is treated in presence of hydrogen, absorption of the latter begins at about 500°, and a state of dissociation equilibrium is produced, the gaseous system containing the vapours of mercury and strontium as well as hydrogen. But as the extremity of the tube is cooled, mercury is here condensed, and the reaction goes on to completion, *i.e.*, to complete replacement of mercury by hydrogen. Strontium hydride dissociates on heating, and the author has measured the dissociation pressures at 1,000° (100 mm.) and at 1,100 (300 mm.) and thence calculated the heat of formation to be 38·4 Cal. A thermochemical determination of this by the action of water on the hydride gave 34·7 Cal. Finally it is shown how a knowledge of the dissociation pressures enables the conditions for the preparation of metallic strontium from the hydride to be accurately given. F. G. D.

1736. *Initial Action of Iodine in Hydrolysis.* **F. E. Hale.** (Zeitschr. Anorg. Chem. 31. 1. pp. 100–127, 1902.)—It has often been stated that on using amidon as an indicator with ideometric methods—in addition to the well-known blue colouring—a red colour will also frequently appear. The author has tested the causes of the iodine losses attending this phenomenon, and this paper not only shows how to avoid these losses, but affords a probable explanation of the appearance of the red colour, of the causes of iodine losses, and of the mutual connection of both phenomena. It is stated that neither of these phenomena will appear with an absolutely pure and recently prepared amidon solution. Common amidon, as a rule, contains two impurities, one of which will assume a red colour on reacting with iodine, the other turning blue; this latter is readily transformed into the former by the action of oxygen and bicarbonate. These impurities are formed also in pure amidon, both in the dry state and in solution. The latter one is found to be identical with, or analogous to, amiduline (soluble amidon), a compound formed by the action of saliva on pure amidon, the red colouring impurity, erythrodextrine, being the second product of the same reaction. Iodine losses are due to the formation of erythrodextrine from the body analogous to amiduline, whereas with the transformation of erythrodextrine into achrodextrine no iodine is consumed. A. G.

1737. *Solubility of Analogous Salts.* **W. O. Rabe.** (Zeitschr. Anorg. Chem. 31. 1. pp. 154–158, 1902.)—It has been shown by C. Rossi's investigations that the ratio between the molecular weights of analogous salts of such metals as are of a very similar chemical nature, and which belong to the same group of the periodic system, will be a multiple (represented by simple numbers) of the ratio of the corresponding coefficients of solubility. The author, extending Rossi's experiments on metals which, though they show numerous analogies among one another, do not belong to the same group, and testing the influence of temperature, fails to note any definite relations between the solubilities of different analogous salts of lithium, sodium, silver, and ammonium, and the corresponding thallo-salts, whereas a simple relation is shown to exist in the case of potassium and thallium. It is suggested that with increase of temperature the salt solutions above mentioned may tend towards an equimolecular state, *i.e.*, the state of greatest analogy. Finally, instances are given of a possible bearing of the acid radical on the phenomena in question. A. G.

1738. *Halogen Salts.* **P. Pfeiffer.** (Zeitschr. Anorg. Chem. 31. 2. pp. 191–235, 1902.)—Some years ago Werner published a systematic discussion of the chloro-salts, with a view to show that all the compounds so far known will behave according to the laws of his system. The author endeavours to prove that the same is true of the bromo- and iodo-salts. It results, in fact, from a very full investigation carried out by him that these salts are perfectly analogous to the chloro-salts, and fill up many gaps existing in their system; on the other hand, a most intimate analogy is found to exist between them and the oxy-salts, so that the author suggests regarding all these bodies as members of one great class of compounds with analogous formulæ of constitution. Finally, a systematic survey of the most important double salts of bromine and iodine is given, and a bibliographical table is annexed. A. G.

1739. *Double Salts of Iodine-trichloride with Chlorides of Bivalent Metals.* **R. F. Weinland** and **Fr. Schlegelmilch.** (Zeitschr. Anorg. Chem. 30. 2. pp. 134–143, March 7, 1902.)—Double salts of iodine-trichloride with metallic chlorides have so far been known in the case of the metals of the alkalis, ammonium and magnesium. The authors enter upon the problem, whether, in addition to those mentioned, other chlorides are capable of combining with iodine-trichloride, it resulting from the experiments made that this is true of the chlorides of zinc, nickel, cobalt and manganese, while attempts to obtain similar compounds with chlorides of trivalent metals failed. The composition of these double salts is found to be represented by the following molecular formula, identical with the formula given by Filhol for the magnesium salt:

$$2ICl_3 . R''Cl_2 . 8H_2O.$$

These salts are prepared by adding iodine (more by one-half than the theoretical value) to the aqueous solution of the corresponding chloride, and allowing chlorine to enter until all the iodine has dissolved. The double salt will separate on cooling, the chlorine current being kept on. The authors finally give a very full description of each of the salts obtained.
A. G.

1740. *Polyhalogen Compounds of Metals of Alkaline Earths.* **J. Meyer.** (Zeitschr. Anorg. Chem. 30. 2. pp. 113–122, March 7, 1902.)—It has been known for some time that iodine will dissolve readily in solutions of its metallic compounds. Wells and Wheeler having shown that the metals of the alkalis are capable of forming definite polyhalogen compounds, the author has investigated the solubility of iodine in 10 per cent. solutions of the haloids of metals of the alkaline earths, the outcome being that this solubility exceeds by far the solubility in pure water. In order next to ascertain whether halogens in such solutions are chemically bound or physically dissolved, the author uses the cryoscopic method, availing himself of an apparatus to be described in a subsequent paper. The main result of these experiments is that the freezing-points of such solutions will be but little altered by the addition of halogens, even the sign of that alteration being variable. Hence the author draws the conclusion that in such solutions there may exist polyhalogen compounds largely dissociated. Endeavours to prepare these bodies in the solid state succeeded only in the case of iodides of metals the alkaline earths. These solid polyiodides the author regards as molecular compounds; while with polyhalogen compounds of the metals of the alkalis, the stability will increase towards cæsium; metals of the alkaline earths will show an opposite behaviour, the calcium compound CaI_4 being the most stable. [See preceding Abstract.] A. G.

1741. *Heat of Reaction between Bodies in the Solid and Gaseous States.* **Ponsot.** (Comptes Rendus, 134. pp. 651–653, March 17, 1902.)—If two bodies A and B produce others, M and N, by chemical reaction, we may consider at the same temperature T, and under the same volume V, two systems, one containing A and B, the other M and N, in each the solid bodies being accompanied by a mixture of their vapours. Supposing in the mixture of vapours, in presence of the solid bodies, a chemical modification at temperature T_1 to increase by dm the second system at the expense of the first, without being accompanied by vaporisation and condensation due to the presence of the solids, it follows that $dU/dm_v = T_1 . ds/dm_v + dt/dm$, where t is the thermodynamic potential; from considering the same modification to occur in the solids it follows that $dU/dm_s = T_1 . dS/dm_s + dt/dm$, and that therefore dU/dm_s and dU/dm_v tend towards the same value as T_1 approaches absolute zero. It is shown further that the heat evolved in the total reaction of the bodies taken in the solid state and under a pressure produced by the pressure of the vapours they emit, and the heat evolved in the total reaction under constant volume of the same bodies in the gaseous state tend towards the same value at absolute zero. [See also Abstract No. 1962 (1901).] W. E. T.

1742. *Mechanism of the Catalytic Action of Iodine on Bromination.* **L. Bruner.** (Acad. Sci. Cracovie, Bull. 3. pp. 181–200, March, 1902.)—In the bromination of benzene in the presence of iodine the author finds that the reaction is of the 2nd order, so far as the calculation of a constant is concerned, but that if examined by the varying concentration method it is really quadrimolecular. This is explained by the equation—

$$C_6H_6 + 4Br = C_6H_5Br + HBr_3.$$

On determining the bromine which has disappeared by titration with potassium iodide and thiosulphate, the four bromine atoms only count as two, since the HBr_3 breaks up into $HBr + Br_2$.

The catalytic action of the iodine is ascribed to the formation of IBr and its dissociation into atoms. When the bromine left in the solution falls to an amount corresponding to the formation of IBr, the reaction falls off greatly in speed. This is ascribed to a decreased dissociation of the IBr, resulting from an increase in the concentration of the iodine atoms with which there is now no excess of bromine atoms to combine. F. G. D.

1743. *Catalysis and its Applications.* **J. T. Conroy.** (Soc. Chem. Ind., Journ. 21. pp. 302–312, March 15, 1902.)—The author refers to Ostwald's address on this subject before the Deutscher Naturforscherversammlung in Hamburg, in September, 1901, and quotes with approval Ostwald's remark that—"there appears to be no kind of chemical reaction which cannot be influenced catalytically, and no form of chemical substance, be it elemental or compound, which cannot act as a catalyst." The author then proceeds to discuss practical examples of catalytic action, the instances selected being chiefly of industrial significance. This portion of the paper is very full and complete, and the classification adopted can only be given in this Abstract. INORGANIC PROCESSES.—*Chlorine and Chlorine Products:* The Deacon chlorine process, the Imhoff chlorate process. *Sulphur:* The Claus kiln action for oxidation of SH_2. *Sulphuric Acid:* All contact processes. ORGANIC PROCESSES.—*Aldehydes:* Trillet's and other processes. *Acetic Acid and Acetone:* Behren's and Squibb's processes. *Carbon tetrachloride:* Lever and Scott's process. The author concludes by drawing attention to the theory of catalytic action, based on intermediate chemical reactions. The importance of the work now being carried on in this field of chemical inquiry is referred to, and its significance for the chemical manufacturer is emphasised. J. B. C. K.

1744. *Solubility of Ammonia in Salt Solutions.* **R. Abegg** and **H. Riesenfeld.** (Zeitschr. Phys. Chem. 40. pp. 84–108, March 18, 1902.)—The partial pressure of ammonia when dissolved in water or in salt solutions obeys Henry's law very closely between the concentrations $\frac{N}{2}$ and N of the ammonia, and in the case of salt solutions the change of pressure is approximately proportional to the concentration of the salt. The alkaline hydroxides, fluorides, borates (KBO_2 &c.), acetates, formates, chlorates, bromates, and iodates, and the salts of all the polyvalent acids greatly increase the partial-pressure of the ammonia, and thus reduce the solubility of the ammonia in the water. The effects are approximately additive, the order of magnitude for the kathions being K, Na, Li, NH_4, and for the anions being OH, F, ClO_3, BrO_3, IO_3, NO_3, Cl, Br, I, &c. In a few exceptional cases, such as $MgCl_2$, $CaCl_2$, $SrCl_2$, $BaCl_2$, LiCl, LiBr, LiI, an opposite effect is produced, the solubility being increased by the presence of the salt; this result is perhaps due to the combination of ammonia with the salts. In the majority of cases the lowering of solubility of ammonia runs parallel with the lowering of solubility of other volatile substances, such as hydrogen, nitrous oxide, carbon dioxide, ethyl acetate, and phenylthiocarbamide; this is true for Na_2SO_4, Na_2CO_3, and the nitrates of the alkali-metals, but in other cases such as $MgSO_4$, $CaCl_2$, and the chlorides of the alkali-metals ammonia behave abnormally, and probably interacts with the dissolved salt, a conclusion that has already been arrived at from the study of the ammonia results by themselves. [See also Abstract No. 1699 (1900).] T. M. L.

1745. *van der Waals' ψ-surface.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 782–793, March 29, 1902.)—In this paper the author applies the relation for the ratio of the compositions of coexisting phases in the presence of small amounts of an impurity to the case of mixtures, by means of the law of corresponding states. This relation is next tested by Hartman's observations with regard to the composition of coexisting phases in mixtures of methyl chloride and carbonic acid. The author subsequently goes on to deduce formulæ for the difference of the saturation pressures of the mixture and the pure substance respectively, and the increase in pressure by condensation of the mixture. These formulæ afford a means of ascertaining the amount of impurity from the increase in pressure observed, the saturated vapour tension of the pure substance being next found from the initial and final condensation pressures of the impure substance. The last formula is finally tested on Kuenen's observations regarding impure ethane, satisfactory accordance being claimed. A. G.

1746. *Microscopical Examination of the Alloys of Copper and Tin.* **W. Campbell.** (Inst. Mech. Engin., Proc. 5. pp. 1211–1250; Discussion, pp. 1251–1272, Oct.–Dec., 1901. Appendix to Reports of Alloys Research Committee.)—The author has studied the microscopical structure of the copper-tin alloys when suddenly quenched at different temperatures in order to stereotype the structure then existing in them. Over 100 photo-micrographs are given of specimens prepared in this way. The results are substantially in agreement with those that have been obtained independently by Heycock and Neville whose diagram [see Abstract No. 1382 (1902)] is reproduced in the discussion on the paper. T. M. L.

1747. *Transformations of Steel by the Dilatometric Method.* **G. Charpy** and **L. Grenet.** (Comptes Rendus, 134. pp. 598–601, March 10, 1902.)—The study of the transformations of steel by the dilatometric method has the advantage that the changes of temperature can be made to proceed at any rate, and transformations can easily be studied at stationary temperatures. The best results are obtained by heating the sample at the rate of about 200° C. per hour; the lag of the transformations is then inappreciable. In all cases a carbon-iron alloy, when heated, exhibits an abrupt contraction in the neighbourhood of the critical point *a*, of the pyrometric measurements, *i.e.*, at about 700° C.; the magnitude of the contraction reaches a maximum at about 0·85 per cent. C. Above this temperature expansion recommences, but with a much smaller coefficient than below the critical temperature; the coefficient then gradually decreases, becomes negative, and again positive. The second contraction is not abrupt like the first, but extends over a range of temperature, and is only noticeable in steels containing less than 0·65 per cent. C. The first contraction is probably due to the resolution of the eutectic alloy (pearlite) of iron (ferrite) and carbide (cementite, Fe_3C.). At higher temperatures the gradual absorption of the excess of ferrite causes a contraction in the case of alloys containing less than the eutectic proportion of carbon, whilst the gradual absorption of the excess of cementite causes an expansion in alloys containing more than the eutectic proportion of carbon. T. M. L.

1748. *Oceanic Salt Deposits. Formation of Langbeinite [and its lower temperature limit in salt-beds at* 37°]. **J. H. van't Hoff, W. Meyerhoffer,** and **F. G. Cottrell.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 15. pp. 276–282, March 6, 1902.)—Langbeinite, $K_2Mg_2(SO_4)_3$, is found in the Stassfurt salt-beds, but cannot be produced at 25°. Schönite, $K_2Mg(SO_4)_2, 6H_2O$, is converted into leonite, $K_2Mg(SO_4)_2, 4H_2O$ at 47·5°, or 41°, according as K_2SO_4, or $MgSO_4$, is present in excess; further dehydration occurs at 72·5°, but the product is not langbeinite, but a complex of the formula $K_2Mg_4(SO_4)_5, 5H_2O$. The conversion of leonite into langbeinite, according to the equation $2K_2Mg(SO_4)_2, 4H_2O = K_2Mg_2(SO_4)_3 + K_2SO_4 + 8H_2O$ takes place on heating in a sealed tube; the transition-temperature was found with some difficulty to be about 89°. The formation of langbeinite from leonite and magnesium sulphate

$K_2Mg(SO_4)_2, 4H_2O + MgSO_4, 6H_2O = K_2Mg(SO_4)_3 + 10H_2O$ takes place above 61° ; if the separation of langbeinite is delayed, the unstable compound $K_2Mg_4(SO_4)_5, 5H_2O$ is liable to separate, but disappears again when langbeinite has begun to crystallise. A solution saturated with K_2SO_4 and $MgSO_4$ contains at 88·5° $1000H_2O, 4MgSO_4, 27K_2SO_4$, and at 61·5° $1000H_2O, 83MgSO_4, 7K_2SO_4$; from such a solution saturated at 85°, or above, langbeinite can be obtained, but a better method of preparation is to add magnesium chloride as a dehydrating agent, and subsequently to extract it with alcohol. The formation of langbeinite from leonite, which is lowered from 89° to 61° by the presence of magnesium sulphate, takes place at 37° in a solution saturated with salt, and this is probably the lowest temperature at which it can have been deposited in the Stassfurt beds. [See also Abstracts Nos. 512 and 735 (1902).] T. M. L.

1749. *Condensation of Vapours of Organic Liquids in Presence of Dust-Free Air.* **F. G. Donnan.** (Phil. Mag. 3. pp. 305–310, March, 1902.)—When expanded adiabatically, water condenses as a fine rain round a few nuclei for expansions above 1·25, but as a fog round a large number of nuclei for expansions above 1·38. It was thought that this behaviour might be general in "ionising solvents," but that condensation would occur less readily in the vapour of non-ionising solvents. It was found that methyl and ethyl alcohol behaved somewhat like water, but that condensation occurred less readily in the case of carbon tetrachloride, benzene, and chlorobenzene ; carbon disulphide, however, though a non-ionising solvent, was found to condense with remarkable readiness. The results are shown in the table :—

	Rain-point expansion.		Dew-point expansion.
Water	1·29	...	1·42
Methyl alcohol	1·32	...	1·42
Ethyl alcohol	1·20	...	1·25
Carbon tetrachloride	1·89	...	Not observed
Carbon disulphide	1·05	...	1·08
Chlorobenzene	1·48	...	1·60
Benzene	1·53	...	1·78

[See also Abstract No. 1025 (1900).] T. M. L.

1750. *Chromium Hydroxide.* **W. Fischer** and **W. Herz.** (Zeitschr. Anorg. Chem. 31. 3. pp. 352–359, 1902.)—It has been known for some time, from W. Herz's and Hantzsch and Rubenbauer's researches, that numerous inorganic compounds will first be produced in a soluble modification, and, by degrees, pass into a more insoluble form. In this paper it is stated that chromium hydroxide, immediately on being prepared, will be capable of readily dissolving in bases. This property, however, is lost slowly on being left undisturbed, more rapidly on being heated, or filtered and dried. A. G.

1751. *Validity of the Ionisation Theory.* **H. M. Dawson.** (Nature, 65. pp. 414–415, March 6, 1902.)—The author criticises a paper on this subject by L. Kahlenberg, in which molecular weights were calculated from experimental results on solutions which were not dilute. [See Abstract No. 2208 (1901).] Since the ordinary freezing-point and boiling-point formulæ rest on a thermodynamical basis, they only hold good for ideal solutions, and it is not justifiable to apply them to strong solutions. For solutions of this kind, Ewan, amongst others, has deduced a formula, which, when applied to sugar solutions, gives values scarcely differing from theory, even up to a concentration of 40 per cent. Since the ordinary formulæ cannot be applied, results derived from them cannot be compared with those due to conductivity measurements; besides which the ranges of concentrations employed by Kahlenberg are quite different. It is also doubtful if the formula $\alpha = \mu_v / \mu_\infty$ really gives degrees of ionisation, for it involves the unproved and scarcely probable assumption that ionic velocities are the same for all concentrations. In attacking the theory it is necessary to consider very carefully what is stipulated in the basis. W. R. C.

1752. *Cuprous and Cupric Ions.* **G. Bodländer** and **O. Storbeck.** (Zeitschr. Anorg. Chem. 31. 1. pp. 1–42, 1902.)—The experiments recorded in this paper lead to the following conclusions: Cuprous chloride, on being exposed to the action of water, is decomposed into cuprous hydroxide and free hydrochloric acid on one hand, and on the other into cupric chloride and metallic copper, the latter process being the prevailing one, and capable of being restrained by the addition of increasing amounts of chlorides, so that cuprous chloride will dissolve without decomposition in solutions more than 0·05 normal with regard to potassium chloride. In aqueous solutions cuprous chloride is present partly ionised. A method, based on measurements of concentration cells, of ascertaining the formula of complex salts in solution has been tested. Solutions 0·05 — 0·4 normal of potassium chloride will dissolve cuprous chloride with formation of the compound $KCuCl_2$, while in more concentrated chloride solutions the formula of the complex salt will be K_2CuCl_3. Since the molecules of the complex cupro-salts contain no more than one atom of copper, these experiments do not afford sufficient evidence as to the mono- or bi-valency of the free ions. [See also Abstract No. 175 (1901).]

A. G.

1753. *Relative Velocities of the Ions in Solutions of Silver Nitrate in Pyridine and Acetonitrile.* **H. Schlundt.** (Journ. Phys. Chem. 6. pp. 159–171, March, 1902.)—The author has determined the migration velocities of the silver ion in solutions of pyridine and acetonitrile. The apparatus employed in most of the experiments was that devised by Nernst and Loeb; in two experiments Bein's apparatus was used. The following tables give the temperatures, the concentrations of the silver nitrate solutions employed, and the transference numbers for the kation, as determined from the change of concentration at the anode and kathode respectively.

	Solvent : Pyridine.										Solvent : Acetonitrile.			
t	23°	18·5°	23°	0°	19°	21°	0°	22°	22°	...	18°	19°	17°	19°
Approximate concentration	*n*	$\frac{1}{9}$-*n*	$\frac{1}{2}$-*n*	$\frac{1}{2}$-*n*	$\frac{1}{10}$-*n*	$\frac{1}{10}$-*n*	$\frac{1}{10}$-*n*	$\frac{1}{40}$-*n*	$\frac{1}{40}$-*n*	...	*n*	$\frac{11}{40}$-*n*	$\frac{1}{11}$-*n*	$\frac{1}{33}$-*n*
N at anode	32·6	34·1	34·3	33·5	40·4	38·7	40·2	43·2	44·7	...	38·5	42·4	45·2	46·9
N at kathode	32·7	—	34·0	33·6	—	38·7	40·6	43·9	44·5	...	38·2	42·0	44·5	47·3

Comparison shows that the transference number of Ag. varies considerably with the solvent, but there is an apparent convergence to the same value, 47. In the case of aqueous solutions of certain salts which show a marked affinity for the solvent, the transference number increases with increasing dilution; this is also the case with Ag in pyridine and acetonitrile solution, and this behaviour leads the author to the conclusion that the variations in the ionic velocities are due to a complex union of solvent and dissolved substance, and not to the presence of several kinds of complex free ions of the solute. A. F.

1754. *Hydrogen in the Atmosphere.* **Rayleigh.** (Phil. Mag. 3. pp. 416–422, April, 1902.)—From determinations of the hydrogen in country air by means of the spectroscope, and by passing dry air over heated copper oxide, and collecting the water formed in a phosphoric oxide tube, the author concludes that the free hydrogen present does not exceed 1/80,000 of the volume, or about 1/7 of that found by Gautier. (Comptes Rendus, 1900, 131. 86.) [See also Abstract No. 886 (1901).] S. R.

1755. *Osmotic Pressure of Solutions Calculated from the E.M.F. of Cells.* **T. Godlewski.** (Acad. Sci. Cracovie, Bull. 3. pp. 146–163, March, 1902.)—If $f(pth)$ is the difference of the thermodynamic potentials $\zeta(pt)$ and $\phi(pth)$ of unit mass of the solvent in the pure state and in the solution, where h is the degree of concentration of the solution, ω its osmotic pressure, the excess of the pressure of the solution p_1 over that of the solvent p_0 when the system is in equilibrium, w the volume of unit mass of the solvent, and μ_s its coefficient of compressibility for pressure p_0, the equation $f(p_1th)=\omega w+\frac{1}{2}\omega^2\mu_s+\frac{1}{6}(\partial\mu_s/\partial p)u^3$ follows from the condition for equilibrium $\phi(p_1th)=\zeta(p_0t)$; the osmotic pressure of a solution of any degree of concentration may then be calculated if the value of f be known. The numerical values of f were obtained for solutions of $ZnCl_2$, $CdCl_2$, $CdSO_4$, of various concentrations from determinations of the e.m.f. of cells of the types Hg—HgCl—$ZnCl_2$—Zn Amalgam, Hg—Hg_2SO_4—$CdSO_4$—Cd (Am), and Hg—HgCl—$CdCl_2$—Cd (Am) by means of graphical integration from the equation—

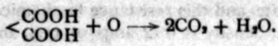
$$\partial f/\partial h=-nF/\mu.h\partial E/\partial h$$

(Duhem, Potentiel Thermodynamique, 1895, p. 117). The effect of taking account of the compressibility of the water is never found to be greater than 3 per cent., as the terms of the second and third degree, having opposite signs, mutually neutralise one another. W. E. T.

1756. *Gas Cells.* **R. Lorenz.** (Zeitschr. Anorg. Chem. 31. 2. pp. 275–279, 1902.)—After discussing Bose's remark on Czepinski's work [see Abstract No. 1156 (1902), the author distinguishes, according to Nernst's theory, four kinds of potentials occurring in gas cells, the first being the case of an electromotively effective gas passing into its ions at an electrode, as H_2, for instance, may pass into H-ions. The second case is that of an electromotively effective gas being mixed with one electromotively ineffective, the latter being at the same time chemically indifferent as well (with regard to all the substances present). Those potentials are what the author terms "physical dilution potentials." As the diluting gas, though electromotively uneffective, is not chemically indifferent, the case of a "chemical dilution potential" will be realised, the partial pressure of the electromotively operative gas corresponding to the state of equilibrium of the chemical reaction occurring, provided the substance produced be electromotively indifferent as well. The last case considered by the author is the one of several electromotively operative gases being present simultaneously at the gaseous electrode, *e.g.*, in the case of oxy-hydrogen gas being led to an electrode, when potentials oscillating between those of oxygen and hydrogen will be obtained. These potentials the author terms "mixture potentials." A. G.

1757. *Velocity of Electrolysis of Oxalic Acid.* **T. Åkerberg.** (Zeitschr. Anorg. Chem. 31. 2. pp. 161–191, 1902.)—When electrolysing a mixture of oxalic acid and sulphuric acid solution with clean platinum electrodes, the oxalic acid is found to undergo electrolysis only to a nearly insensible degree.

On using platinised anodes, the oxalic acid will be decomposed; from this fact it is inferred that this reaction is a secondary phenomenon, *i.e.*, that the decomposition of the oxalic acid is due to a purely chemical action of the oxygen evolved by electrolysis. This reaction may follow two different laws, according to concentration. In the case of the amount of oxalic acid being large, the decomposition will practically follow Faraday's law, especially as the current density is small and the temperature high. But after a certain dilution of the solution, electrolysis will occur according to the monomolecular law, $dx/dt = k(a - x)$, the passage between the two laws being fairly abrupt. The transition-point is found to be dependent upon the current density, the monomolecular law beginning later, as the current density is less. This reaction being a monomolecular one, the oxygen cannot act as a molecule O_2, but will act as an atom O. It will hence occur according to the following scheme:—



$$<^{COOH}_{COOH} + O \longrightarrow 2CO_2 + H_2O.$$

The constant k is found to be independent of the current density, affording further evidence in favour of secondary chemical nature of the reaction. Between 15° and 55° this constant will practically vary as the temperature.

A. G.

1758. *Direct Combination of Chlorine and Carbon.* **W. v. Bolton.** (Zeitschr. Elektrochem. 8. pp. 165–170, March 20, 1902.)—Hitherto no direct combination of carbon with chlorine has been observed. Davy found that an arc between carbon poles in an atmosphere of chlorine brought about no combination. The author has examined the effect of burning an arc light in different gases. If the arc be started in a vacuous receiver, and a little air admitted, first CO_2 and then CO is produced. On admitting more air there is a violent explosion, due to the mixture of CO and O_2. If the receiver be filled with HCl gas, at first there is decomposition into H_2 and Cl_2, followed by recombination with explosion. If acetylene, benzene vapour, or many other gases rich in carbon be used, a thick deposit of soot is rapidly formed, and the arc stopped. On making the arc between carbon poles in an atmosphere of carbon tetrachloride, the latter was split up into carbon and chlorine. When a stream of pure dry chlorine was passed through the apparatus, the carbon electrodes were acted upon, but no product was isolated; however, on allowing the arc to burn in the receiver, full of chlorine, the author obtained about 0·02 grm. of a white crystalline body, which was deposited on the sides of the vessel, and had the melting-point and properties of hexachlor benzene C_6Cl_6. To obtain this amount of substance, a current of 5·5 amperes and 42 volts was passed for six hours. To improve the yield, the author constructed another form of apparatus, the upper part of which contained the arc in chlorine gas, and the lower a circular vessel, immersed in a cooling mixture to facilitate the separation of the volatile carbon chloride. The amount of oxygen contained in the electrodes was altogether negligible, so that the formation of $COCl_2$ was not possible, except in traces. After passing a current of 6 amperes and 48 volts for a period of six hours, about 0·6 gram of a white crystalline solid was obtained, smelling of camphor, and having a melting-point of 114° C.–186° C. Both quantitative and qualitative analyses led to the formula C_2Cl_6, hexachlorethane. The carbon electrodes were acted on differently, the negative one being pitted with small uniform holes. The author considers it probable that carbon also combines directly with bromine and iodine, as by operating in a similar manner he was able to obtain crystalline deposits; he has not yet been able to complete his researches in this direction, owing to lack of time. The paper contains diagrams of the apparatus used. W. C. B.

1759. *Artificial Graphite and Platinumiridium as Anode Material.* **F. Foerster.** (Zeitschr. Elektrochem. 8. pp. 143–147, March 6, 1902. From the Elektrochem. Laboratorium der Techn. Hochschule at Dresden.)—The author has carried out experiments with artificial graphite prepared by the Acheson method, with a view to determining its usefulness and efficiency as anode material in the electrolysis of aqueous solutions. Employed as anode in the electrolysis of a neutral, 20 per cent. solution of sodium chloride in the presence of chromate, at a temperature of 60°, with a current density of 0·04 amp./sq. cm., only 7·4 per cent. of the current energy is lost owing to attack of the graphite, and this resistance to chemical attack is maintained even when the current density is 0·12 amp./sq. cm., and the electrolysis continued for 100 hours. When, however, the graphite is used as anode in the electrolysis of sulphuric acid its resistance to chemical attack is no greater than that of amorphous carbon, although the mechanical destruction is not nearly so great, and there is no formation of humus substances. In the electrolysis of solutions of caustic soda at the ordinary temperature Acheson graphite is almost unacted on, and there is no formation of brown, soluble oxidation products, and this holds also even when the temperature is 60–70°, although in this case the graphite is appreciably attacked. Artificial graphite is, therefore, greatly superior to amorphous carbon as anode material in the electrolysis of solutions where the anode potential of the oxygen is comparatively low, but this superiority disappears when the oxygen potential becomes fairly great, as in the electrolysis of dilute sulphuric acid. The author has also studied the use of a platinumiridium alloy, free from ruthenium, and finds that, whether employed as anode or as kathode in the electrolysis of neutral potassium chloride, in presence of chromate, at a temperature of 45°, the electrode remains unimpaired even when the current density is 1,000 amp./sq. m. and after the passage of 2,500 ampere-hours. A. F.

1760. *Formation of Calcium Carbide.* **V. Rothmund.** (Zeitschr. Anorg. Chem. 31. 1. pp. 136–146, 1902.)—Raising the temperature may have two different effects on chemical processes, as the reaction occurring at low temperatures may take place with far greater velocity at high temperatures, and as, on the other hand, rise of temperature will often alter the chemical affinity. A diminution of free energy attending the reaction, the equilibrium is displaced and the direction of the reaction is frequently reversed in the latter case.

As, in the case of carbon, both phenomena may occur, the author tests the conditions of the formation of calcium carbide in the electrical furnace. A carbon tube traversed by the electric current served as furnace, and temperatures were measured by determining the amount of visible radiation given off by this "black" body, as was first suggested by Ed. Becquerel (1864). A mixture of coal and lime was heated to a white heat within this furnace, and, after cooling, the amount of carbide was ascertained by treating the residue with water. From these experiments it is inferred that the formation of calcium carbide is a reversible phenomenon, as, below the transition-point, decomposition of carbide by carbon monoxide into lime and carbon will take place. A. G.

1761. *Theory of the Electrolytic Rectifier.* **K. Norden.** (Elect. World and Engineer, 38. pp. 681–682, Oct. 26, 1901.)—Rectification cannot be due to back e.m.f., for, on stopping a cell, the e.m.f. is found not to exceed 3 volts at the most. Neither can the effect be explained by the high resistance of the film giving rise to a condenser. The author's work has shown that the film consists simply of $Al_2(OH)_6$, which is acted on chemically, passing into solution during half of each period, the plate being oxidised during the other half. W. R. C.

1762. *Electrolytic Conductivity of Liquids.* **G. di Ciommo.** (N. Cimento, 3. pp. 97–121, Feb., 1902.)—The distinction between conducting and non-conducting liquids is only a matter of degree, for all liquids conduct to some extent. The amount of resistance in mixtures cannot be calculated from the simple consideration of the respective percentages; it is generally less than would have been expected, but the divergences vary with the percentages. Abnormalities are fully discussed; the condition of the liquid becomes profoundly modified upon the mutual solution of two liquids. A. D.

1763. *Electrolytic Reduction of Nitric Acid.* **J. Tafel.** (Zeitschr. Anorg. Chem. 31. 3. pp. 289–326, 1902.)—This is an investigation of the alterations which nitric acid will undergo by electrolysis in the neighbourhood of the kathode, considerable amounts of sulphuric or hydrochloric acid being present. A reduction will occur with most kathodes, excepting, for instance, platinum. The mean products of this process are ammonia and hydroxylamine, their ratio depending on a whole series of factors, and varying to a high degree, according to the nature of the kathode, whereas the sulphuric and hydrochloric acids do not seem to exhibit any marked differences. The largest amounts of hydroxylamine are evolved with pure mercury kathodes, or well amalgamated electrodes, the formation of ammonia being almost wholly prevented in some cases, so as to obtain a nearly perfect quantitative transformation of nitric acid into hydroxylamine salt, whereas, in the case of lead kathodes, the amount of the acid transformed into hydroxylamine was not higher than 40 per cent., for copper 15 per cent. at the most. The rate of this reduction is smallest in the case of copper electrodes. It is next shown that, with electrodes giving rise to this reduction process, hydroxylamine sulphate will equally be reduced, and *vice versâ*. From these facts it is argued that the electrolytic reduction of nitric acid to ammonia at copper kathodes does not pass through hydroxylamine. In order to account for these phenomena, an hypothesis analogous to Chilesotti's interpretation of the effect of different kathodes on the reduction of nitrobenzol is suggested, certain materials, as, for instance, copper, transforming the reduction process leading from nitric acid to hydroxylamine, by a chemical action, from its essentially electrolytic nature, so as to produce ammonia directly. These experiments tend to show the existence of a specifically electrolytic reduction effect with a given kathode and a given electrode, this effect being in some cases not only quantitatively, but qualitatively, different from the corresponding chemical effect. A. G.

REFERENCE.

1764. *Determination of Capillarity-constants.* **M. Cantor.** (Ann. d. Physik, 7. 3. pp. 698–700, March, 1902.)—This is a criticism of Whatmough's method of determining capillarity-constants [see Abstract No. 734 (1902)], containing a description of a modified form of apparatus for the purpose. T. M. L.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1765. *Oscillating Compound Engine.* (Scientific American, 86. pp. 384–385, May 31, 1902.)—This is a compact semi-rotary engine in which the pistons consist of radial blades, which oscillate between the walls of chambers which form the cylinders. Steam is admitted to these chambers by means of slide valves. The stroke of the blades is 8 in., and they are carried by a shaft on which is keyed a pinion gearing with a sector on a parallel shaft. Motion is transmitted from the sector-shaft to the crank-shaft by means of connecting rods. The crank-throw is 3 in. An engine capable of developing 9 b.h.p. occupies about 1 cub. ft. C. R. D'E.

1766. *Fuel Oil.* **W. W. Reed.** (West. Electn. 30. pp. 302–303; Discussion p. 303, May 3, 1902. Paper read before the South-Western Gas, Electric and Street Rly. Association at San Antonio, Texas, April 19, 1902.)—This paper deals with the advantages inherent to the use of oil fuel as regards cost of handling fuel, steaming capacity, cleanliness, and safety, control of firing, and economy. It is based on the facilities yielded by the oil supply at Beaumont, Texas. Comparisons of the calorific values of oil and coal are taken from Professor Phillips' report on Texas petroleum, in which he gives 17,000 to 20,000 B.Th.U. as the heat value of petroleum, assuming an average of 18,500 B.Th.U. For Alabama coals he gives 13,500 B.Th.U., the same for good McAlester coal; for New Mexico coal 12,000, and for Lignite 9,900 B.Th.U. On this basis one barrel of crude petroleum weighing 320 lbs. net, would be equal to 438 lbs. Alabama or McAlester coal, 492 lbs. New Mexico coal, and 598 lbs. of Lignite. The calculated number of barrels of oil equal to 1 ton of coal would be:—

1 ton	Alabama coal	equal to	4·56	barrels of oil.
1 „	McAlester coal	„	4·56	„ „
1 „	New Mexico coal	„	4·06	„ „
1 „	Lignite coal	„	3·34	„ „

Results based on practice give from 2¼ to 4 barrels of oil to a ton of soft coal. An evaporative test made by the Houston Electric Company with two Babcock-Wilcox boilers gave 13·48 lbs. of water evaporated from and at 212° F. per lb. Texas oil, which weighed 7·43 lbs. per gall. Another test by the Houston Water Company showed an evaporation of 14·71 lbs. water from and at 212° F. per lb. oil. Regarding the relative efficiencies of different forms of burners, four kinds gave the following results:—

No. 1 burner	0·713	gallons per kw.-hour.
No. 2 „	0·667	„ „
No. 3 „	0·606	„ „
No. 4 „	0·575	„ „

The high efficiency of No. 4 was due to the use of highly superheated steam, and a device for intimately mixing it with the oil. The construction of the firebox also greatly influences the result. Although the sulphur in

Beaumont oil has been estimated by analysis at from 1·83 to 2·04 per cent. no bad effects on boiler surfaces have been produced. In the discussion, **F. C. Bitgood** gave the experience of the Hartford Steam Boiler and Insurance Company as to the effects of Beaumont and Corsicana oil on boilers, and corroborated the statements that there were no deleterious effects, but that there was less wear and tear, due to even heating, and consequently less repairs. He, however, warned users as to the danger of raising steam too quickly from cold boilers, and of unduly forcing the boilers, the large supply of flame from the oil exposing them to both of these results unless care were exercised. F. J. R.

1767. *Comparative Boiler Trials in Italy.* (Engineering, 73. pp. 685–687, May 16, 1902.)—This is a preliminary article giving data of the dimensions of the hulls and machinery of the warships *Giuseppe Garibaldi*, and *Varese*, the one having Niclausse boilers, and the other Belleville boilers, comparative trials of which are being carried out by the Italian Government. Unfortunately these ships have not been built to the same lines, nor are the details of engines, boilers, or propellers identical, so that the trials are robbed of much of their value for comparison. The article, however, illustrates and describes the ingenious electrical apparatus invented by L. Perroni for signalling in each of the stokeholds the time at which the fires must be stoked, in accordance with the rate of total combustion per hour determined upon for a given h.p. This apparatus has been found to work admirably, and to tend to economy of fuel, as well as to lessening the labour of the stokers. It, of course, eliminates the irregularity due to chief stokers preferring to govern the stoking by the steam pressure or some other element. It consists of a clock with different series of electrical contacts (according with the different grades of stoking worked out for the engines and boilers) controlled by a switch. These operate electric bells in the stokeholds, and thus give automatic signals in them all simultaneously. F. J. R.

1768. *Alberger Cooling Tower.* (Eng. and Mining Journ. 73. p. 665, May 10, 1902.)—This tower is made in two forms, one for a natural draught of air, due to the air becoming heated by the hot water from the jet condenser, and one for the use of fans for circulating the air. The former has a stack above the cooling-tower proper, and is usually made 80 ft. high above ground level. Illustrations of these forms, with the accompanying condensing and pumping plant, accompany this article. F. J. R.

1769. *The Underfeed Stoker.* (Electrical Times, 21. pp. 947–948, June 19, 1902.)—This is one of the most recent forms of apparatus for supplying coal to furnaces below the bars, so that the green coal is delivered at the underside of the fire instead of being thrown on its surface. The difficulties formerly encountered in efforts to apply this system of feeding fires are in this case dealt with by causing the grate to slope downwards towards both sides from the centre, the feeding-trough being directly under the apex at that point. The grate-bars are made of peculiar section, and are hinged and linked together so as to permit of a modified rocking motion, which tends to spread the fuel. The hopper-trough, with its hollow steel-feeding helix, has a diminishing area towards the rear of the furnace. This causes the fuel to be gradually forced upwards, and the creeping movement of the bars spreads it in a uniform layer over the bars. The hopper outside the furnace has also some useful features, and the dead plates being at the sides, and not at the back of the furnace, facilities for examination and cleaning are present in this design, which others have lacked. Some tests have shown good evaporative results, figures of which are given. F. J. R.

GAS AND OIL ENGINES.

1770. *Revolutions and Turning Moment of High-speed Petrol Motors.* **R. Conrad.** (Motorwagen, 5. pp. 71–76, March 15, 1902.)—This article describes the results of experiments conducted on the "Protos" motor with the object of showing that in high-speed petrol motors the increase in turning moment is practically proportional to the diminution in speed and *vice versâ*, as in an electric motor. The experiments were made by counting the speed of the motor under different brake loads, and the following formulæ, deduced from data given in the paper, were employed in calculating the horse-power and mean effective pressure p_m per sq. cm. on the piston during the explosion stroke: $\text{h.p.} = 363\ \text{P.n.}\ 10^{-6}$, and $p_m = 0{\cdot}435\ \text{P}$, where P is the brake load in kilogrammes, and *n* is the number of revolutions of the motor. The results of the tests are expressed in the following table, which shows that the relationship above referred to is practically correct, the deviations from proportionality being due probably to experimental errors in the determination of the speeds.

P.	n.	h.p.	pm
8	1,697	4·9	3·48
9	1,756	5·7	3·92
10	1,544	5·6	4·35
11	1,561	6·2	4·79
12	1,492	6·5	5·22
13	1,410	6·6	5·66
14	1,261	6·4	6·09
15	1,206	6·6	6·53
16	1,120	6·5	6·96

The paper, which gives a comparison of the results with those obtained in similar experiments on other types of motors, is illustrated by curves, and also contains a mathematical investigation of the number of revolutions at which the h.p. is a maximum. The importance of proper adjustment of the carburettor and ignition for obtaining the maximum efficiency of the motor is also pointed out. J. G

1771. *Crowden Petrol Motor.* (Engineer, 93. p. 520, May 23, 1902.)—This is a double cylinder, horizontal engine, in which the pistons are coupled to overhung cranks on a crank-shaft carrying the flywheel at the centre of its length. The bodies and heads of the cylinders are castings, but the water-jacket is formed of sheet metal, and constitutes also the water-tank. The inlet valves are automatic, and the exhaust valves mechanically operated. This operating gear consists of two strikers coupled to the ends of a lever pivoted at its centre. The lever is oscillated by connection to an eccentric pin on a disc geared to rotate at half the speed of the crank-shaft. The ignition is electric. C. R. D'E.

1772. *Blake Motors.* (Automotor Journal, 7. pp. 152–154, May 24, 1902.)—These petrol motors are of the vertical type, having either two or four cylinders. In either case the bodies, heads, and water-jacket of a pair of cylinders form one casting, which is bolted down to the crank-enclosing chamber. The inlet and exhaust valves are placed vertically over one another. The exhaust-valve mechanism is enclosed, as is also the centrifugal governor which controls the admission of gas to the cylinders. The body of the crank chamber is formed of a single casting, the crank-shaft being inserted by means of circular end doors. High-tension electric ignition is employed. With aluminium crank chambers the 9-h.p. two-cylinder engine weighs, with flywheel, 200 lbs., and the 14-h.p. four-cylinder 300 lbs. C. R. D'E.

1773. *Schmidt Launch Motor.* (Motorwagen, 5. pp. 127–128, April 30, 1902.)—This article describes the launch motor constructed by Messrs. Richard Schmidt & Co., of Leipzig. The motor, which is of the well-known Daimler type, has two cylinders with cranks arranged at 180°, and developes 12 h.p. at 800 r.p.m. The only noteworthy feature in the motor is the formation of the crank chamber as an oil-bath, in which is immersed the gearing between the crank-shaft cam and the two-to-one cam-shaft from which the valves and the cooling water circulating pump are operated. The motor is clearly illustrated, and a table is given showing its principal dimensions.

J. G.

1774. *Gasoline and Kerosene as Fuel for Explosive Engines.* **L. Berger.** (Horseless Age, 9. pp. 630–632, May 28, 1902.)—The author has made some experiments with a gasoline of formula, $41{\cdot}86C_6H_{14} + 6{\cdot}48C_7H_{16} + C_5H_{12}$. He finds that the calorific value of this gasoline is about the same as that of hexane (C_6H_{14}). With air as the source of oxygen for the combustion, the reaction is as follows : $C_6H_{14} + 9{\cdot}5O_2 + 36{\cdot}1N_2 = 6CO_2 + 7H_2O + 36{\cdot}1N_2$. If w be the atomic weight, and c the specific heat of a gas, then according to Berthelot, $cw = a + bt$. For triatomic substances, as CO_2 and H_2O, a is 6·2 and b is 0·005. For biatomic substances, like N_2, a is 4·8 and b is 0·002 ; t is temperature of combustion in degrees Centigrade. Berthelot has also shown that if q represents the total heat liberated in a reaction, then—

$$\int_{t_0}^{t} \Sigma nwcdt = q,$$

and, substituting $a + bt$ for cw, we obtain $q = At + Bt^2$, where $A = na$ and $B = \frac{1}{2}\Sigma nb$. For gasoline or hexane we have therefore—

$$A = (6+7) \times 6{\cdot}2 + 36{\cdot}1 \times 4{\cdot}8 = 254,\ B = (6+7) \times 0{\cdot}0025 + 36{\cdot}1 \times 0{\cdot}001 = 0{\cdot}07.$$

In the formation of CO_2 there are liberated 94,300 calories per 44 kg. The formation of H_2O furnishes 58,200 calories per 18 kg. The separation of hexane into its elements requires 19,800 calories per 86 kg. Hence the formation of CO_2 liberates $6 \times 94{,}300 = 565{,}800$ calories, that of H_2O, $7 \times 58{,}200 = 407{,}400$ calories, and the separation of C_6H_{14} absorbs 19,800 calories, leaving a total liberation of 953,400 calories. Consequently, the combustion of gasoline or hexane liberates $953{,}400/86 = 11{,}086$ calories per kg. Substituting in the equation $q = At \times Bt^2$, we obtain $953{,}400 = 254t + 0{\cdot}07t^2$, which gives $t = 2{,}800°$. Average kerosene consists chiefly of decane ($C_{10}H_{22}$). For the reaction which takes place when kerosene is burned the author takes that corresponding to the combustion of decane. The equation will be—

$$C_{10}H_{22} + 15{\cdot}5O_2 + 58{\cdot}9N_2 = 10CO_2 + 11H_2O + 58{\cdot}9N_2,$$

so that—

$$A = (10 + 11) \times 6{\cdot}2 + 58{\cdot}9 \times 4{\cdot}8 = 413,$$

and—

$$B = (10 + 11) \times 0{\cdot}0025 + 58{\cdot}9 \times 0{\cdot}001 = 0{\cdot}111,$$

giving a total of 1,560,000 calories, or 11,000 per kg. The equation for the temperature developed is $418t + 0{\cdot}111t^2 = 1{,}560{,}000$, or $t = 2{,}324°$.

When combustion takes place in a closed vessel, the ratio P/P_o, which determines the power of an explosion, is given by the equation $P/P_o = V_oT/273V$, but $V_o/V = \Sigma no/\Sigma n$, giving $P/P_o = 9{\cdot}93$ for gasoline, and 10·08 for kerosene.

The combustion of 86 kg. of gasoline require $9{\cdot}5 \times 32 = 304$ kg. oxygen, which corresponds to 11,800 cm. of air per kg. gasoline. The volume of 1 kg. of gasoline vapour is 254 cm.; therefore the volumetric ratio of gasoline vapour to air to give the sharpest explosion is $254/11{,}800 = 2{\cdot}15$ per cent. Similar calculation gives the volumetric ratio of kerosene vapour to air 1·35 per cent.

Carburation.—The vaporisation of gasoline requires a surface per h.p. of 221 sq. cm., heated to about 82° C., the pressure of the vapour mixture being 760 mm. of mercury. The gasoline must fall on the surface drop by drop. In the case of spraying carburettors, the velocity of the air must be 25 m. per second; the vaporisation surface can be less than 221 sq. cm. The gasoline vapour diffuses in air with a velocity of 5 mm. per second. Knowing the speed of the suction, it is easy to calculate the openings in the gauze required and the length of suction pipe in order that the gasoline vapour may have time to completely penetrate the air before it is admitted to the cylinder. The vaporisation of kerosene requires a surface of 200 sq. cm. per h.p., heated to a temperature of 220° C., the pressure being 760 mm. of mercury. The kerosene must be thrown drop by drop on the surface. With a kerosene motor running at 720 r.p.m., the total volume of the suction pipe and mixing chamber must be at least four-fifths of the piston displacement. A table is given showing the various properties of the two fuels. C. C.

1775. *Fuel for Automobile Explosive Engines.* **A. L. Clough.** (Horseless Age, 9. pp. 627–628, May 28, 1902.)—The author refers to the Long Island Endurance Test [see Abstract No. 548 (1902)], and regrets that gasoline consumption tests were not brought more into prominence. The gasoline cost in America is only about 3 per cent. of the total cost of running an ordinary automobile. But considering that future improvements in tyres, engines, gearing, &c., must vastly reduce the cost of repairs, the question of fuel consumption should now be considered more seriously. The price of gasoline is rapidly increasing, and its supply is very limited, whereas kerosene is a material of which the supply is practically unlimited, and is much cheaper per unit of energy. More attention should therefore be paid to the carburation of kerosene. C. C.

1776. *Kerosene Carburettors and Burners.* **L. Berger.** (Horseless Age, 9. pp. 637–639, May 28, 1902.)—In the French system of carburation for motors, the kerosene flows through a coiled tube heated by the exhaust, and is afterwards sprayed. Drawings of the Longuemare carburettor [see Abstract No. 1144 (1900)] for kerosene and alcohol are shown, as well as the kerosene carburettors used on the Diedricks and Vosper motors. The author describes burners of Longuemare, Serpollet, Lifu, and Clarkson. C. C.

1777. *Float Feed Carburettor of the Marienfelde (Berlin) Motor-Boat and Motor Manufacturing Co.* (Motorwagen, 5. p. 96, March 31, 1902.)—This article describes the new Marienfelde double-float feed carburettor, which is intended for use with motors employing a mixture of benzine and alcohol. Two chambers, supplied with benzine and alcohol respectively, contain floats for automatically maintaining the liquid in the chambers at constant levels. These chambers are situate on opposite sides of a main mixing-pipe, and communicate therewith through separate induction nozzles and a two-way valve, the air supply taking place along with the alcohol. The charge supplied to the cylinder from the mixing-pipe is controlled by a throttle-valve regulated from the engine in the usual manner. J. G.

1778. *Napier Induction Valve.* (Automotor Journal, 7. pp. 95–96, May 10, 1902.)—This is similar to the ordinary form of flat-seated, spring-controlled automatic induction valve commonly employed in petrol engines, but in addition to the area opened around the periphery of the valve when lifted, there are four apertures in the valve disc close around the valve stem. Pressure-tight seatings are provided round these apertures, and concentric with the exterior seating. This valve opens nearly 1·5 times more area than the simple disc valve, for an equal lift. C. R. D'E.

AUTOMOBILISM.[1]

1779. *Automobile Cars on Railway Lines.* **Hempel.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 464–465, March 29, 1902. Paper read before the Bavarian Section, Jan. 18, 1901.)—The author points out that in local railway lines not connected with commercial centres it is not usually possible to run daily with economy more than two trains travelling to and from the terminal stations; and in order to increase the earning capacity of such lines he proposes that motor traction cars should be run to supplement or displace the ordinary trains. After consideration of the various available sources of power for driving the cars, he concludes that a steam-driven car having a Serpollet [see Abstracts Nos. 902, 903, and 1732 (1900)] generator is most suitable. He then discusses the results of trials made with a Serpollet railway car built for the Würtemberg State Railway in 1897. The boiler employed in this case was capable of developing 35 h.p., and worked at a normal pressure of from 15 to 20 atmospheres. It was fitted with a Worthington injection water-pump driven from the engine shaft, and for starting purposes a separate hand-operated pump was provided. The total steam space was 20 litres, as against 160 litres for a locomotive boiler of the same power. The steam was superheated to a temperature of from 350° to 450° C., and special arrangements were adopted to prevent overheating of the boiler tubes when the car was stationary. The superfluous steam from the boiler was employed for heating the car. The chief drawback found in working the boiler was that, in order to prevent incrustation of the narrow steam space, it was necessary to employ very pure water of 5 to 7 degrees of hardness, and even then it was found that an acid solution of 1 in 4 had to be forced through the tubes once a fortnight for the purpose of removing the scale.

The total cost of running the vehicle, exclusive of interest and depreciation, was 23 pfg. per km., which was made up as follows: Fuel, 9 pfg.; attendance, 10 pfg.; and 4 pfg. for repairs. For an ordinary locomotive on a local line the total running expense is stated to be 40 pfg., of which 20 pfg. is required for fuel, 13 pfg. for attendance, and 7 pfg. for repairs. J. G.

1780. *Brake Tests of Automobiles and Horse-drawn Vehicles.* (Horseless Age, 9. pp. 565–567, May 7, 1902.)—Particulars are given of a complete series of tests of the pulling-up powers of automobiles and horse-drawn vehicles travelling at speeds from under 10 m.p.h. to their maximum on a level road.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

SPEED UNDER 10 MILES PER HOUR.

Vehicle.	Weight. Lbs.	Speed. Miles per Hour.	Stopping Distance. Feet and Inches.
Oldsmobile (gasoline)	600	8·7	8·9
White (steam)	1,350	10	17·2¼
		7·5	6·9½
Locomobile (steam)	1,000	7·8	5·9
Autocar (gasoline)	1,050	9·2	18·1⅛
		9	20·4
		9	17·8½
		8	9·10
Waverley (electric)	1,050	9·4	11·5
		8·7	4·4½
Toledo (steam)	1,400	7·6	4·9½
Panhard (gasoline)	2,500	9·4	5·11
		6·9	3·10
Gasmobile (gasoline)	2,100	9·2	10·0⅝
		6·7	5
Peugeot (gasoline)	2,100	6·4	4·2
		7·6	7·11½
Friedman (gasoline)	1,000	6·9	7
Packard (gasoline)	2,500	7·2	6·8
Long Distance (gasoline)	1,400	7·6	4·9
Haynes-Apperson (gasoline)	2,000	4·5	4·6

SPEED UNDER 17 MILES PER HOUR.

Vehicle.	Weight. Lbs.	Speed. Miles per Hour.	Stopping Distance Feet and Inches.
Oldsmobile (gasoline), 2 persons	800	14·4	21·7
Pierce (gasoline), 2 persons	650	13·8	24·0¼
		15·6	33·8½
White (steam), 2 persons	1,350	15·0	31
Locomobile (steam), 1 person	1,000	16·3	30·9
Autocar (gasoline), 2 persons	1,050	14·4	31·8
Waverley (electric)	1,050	13·8	21·5
Toledo (steam), 1 person	1,400	12·8	15·2
		16·3	34
Panhard (gasoline), 2 persons	2,500	16·3	25·4½
		13·8	22·8
Gasmobile (gasoline), 2 persons	2,100	12	9·9½
		15	22·2½
Peugeot (gasoline), 4 persons	2,100	15·6	40·10
Friedman (gasoline)	1,000	8·3	10·2¼
Packard (gasoline), 3 persons	2,500	13·3	26·7
Haynes-Apperson (gasoline), 3–4 persons	2,000	13·8	21·2¼
		16·3	36·8
Long Distance (gasoline)	1,400	15·6	25·11½
Riker (electric)	1,500	11·2	43·5

SPEED 20 MILES PER HOUR.

Vehicle.	Weight. Lbs.	Speed. Miles per Hour.	Stopping Distance. Feet and Inches.
Oldsmobile (gasoline), 1 person	600	20	60·6
White (steam), 1 person	1,350	21·1	75·2
Locomobile (steam), 2 persons	1,000	22·5	51·5
Autocar (gasoline), 2 persons	1,050	20	69·3
Toledo (steam), 2 persons	1,400	20	45·8
Panhard (gasoline), 2 persons	2,000	18·9	34·6
Gasmobile (gasoline), 2 persons	2,100	20	34·11½ [1]
Friedman (gasoline)	1,000	17·1	59·9
Mors 8 (gasoline) (8 h.p.)	—	22·5	75·9
Long Distance (gasoline), 2 persons	1,400	18·9	29·2

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[1] Car turned completely around in stopping.

TEST UNDER FULL SPEED.

Vehicle.	Weight. Lbs.	Speed. Miles per Hour.	Stopping Distance. Feet and Inches.
Toledo (steam)	1,400	27·6	122·1
Oldsmobile (gasoline)	800	20	58·6
Mors (gasoline)	—	30	125·8
Panhard (gasoline)	2,500	25·7	89·7
Gasmobile (gasoline)	2,100	27·6	114·7
Long Distance (gasoline)	1,400	21·1	60·4¼
White (steam)	1,350	27·6	Failed to stop.
Locomobile (steam)	1,000	32·5	139

By comparison a test was made of the braking powers of horse-drawn vehicles and bicycles, as follows :—

Vehicle.	Speed. Miles per Hour.	Stopping Distance. Feet and Inches.
Payne Whitney's four-in-hand	9	25·11¼
Payne Whitney's four-in-hand	16·3	77·6
Payne Whitney's four-in-hand	18·0$\frac{9}{10}$	90·10
Victoria and pair	9	17·7¾
Victoria and pair	13·0$\frac{6}{10}$	36·10
Bicycle (policeman)	9·0$\frac{4}{10}$	8
Bicycle (policeman)	20	61·6
Bicycle (policeman)	27·0$\frac{8}{10}$	31·2

These tests were conducted in New York City under the auspices of the Automobile Club of America. C. R. D'E.

1781. *Kühlstein-Vollmer 60-h.p. Locomotive.* (Motorwagen, 5. pp. 97–98, March 31, 1902.)—The article deals with a traction locomotive of the Kühlstein-Vollmer type [see Abstract No. 2453 (1901)] specially designed for displacing oxen in the transportation of goods over the desert country between the sea-coast and the frontier of German territory in South Africa, a distance of 80 km. The motor has four cylinders, and developes 60 h.p. maximum and 45 h.p. normal, at from 600–900 r.p.m. The diameter of the cylinders is 145 mm. and the stroke 170 mm. The motive power is furnished by petroleum. The wheels of the vehicle are made of large diameter and breadth, in order to enable the hollows in the ground to be easily traversed and to prevent the wheels sinking into the sand. The diameter given is 1·5 m. and the breadth 350 mm., and, where the sand is specially soft, the breadth may be increased to 800 mm. by means of auxiliary rings carried on the vehicle.

A special feature of the vehicle is the large tractive effort which it is capable of exerting. It has a tare weight of 4,200 kg., can carry a load of 7,000 kg., and is capable of drawing four loaded trailers having a gross weight of 20,000 kg. The following tabular statement shows the tractive effort and gear transmission ratios of the vehicle at different speeds :—

Speed in Km. per hour.	Tractive Effort in Kg.		Gear Ratios.
	Normal.	Maximum.	
1·70	2,400	3,100	1·0
3 25	1,800	2,300	1·9
6·00	1,200	1,500	3·5
10 00	600	800	6·0

Where specially steep inclines are encountered, the motor vehicle makes the ascent alone, then anchors, and draws the trailers up the incline by means of a rope. In ordinary cases the trailers are drawn up one by one. J. G.

1782. *Wolseley Cars.* (Automotor Journal, 7. pp. 164–169, May 31, 1902.)—A detailed illustrated description is given of the latest types of Wolseley engines and cars. The engines, single cylinder 5-h.p., double cylinder 10-h.p., and four cylinder 20-h.p., are all of the horizontal type, water cooled, and fitted with electric ignition. In the 5- and 10-h.p. cars the transmission is by a single Renolds' chain to a spur-wheel change-speed gear, and finally from the differential cross-shaft to the rear road wheels by roller chains. In the 20-h.p. cars a similar mechanism is employed, but the power is transmitted to the change-speed gear by two Renolds' chains. Illustrations of the 35-h.p. racing car are also given. [See also Abstract No. 165 (1902).] C. R. D'E.

1783. *Bardon Car.* (Automotor Journal, 7. pp. 70–73, May 3, 1902.)—The general arrangement of the mechanism in the latest types of Bardon car is illustrated and described. The main features are similar to those of earlier types, the engine in the 12-h.p. car being of the double cylinder four-piston horizontal type with two crank-shafts, and the transmission comprising bevel and spur gear between engine and differential cross-shaft, and chain drives to the rear road wheels. C. R. D'E.

1784. *Napier Lorry.* (Automotor Journal, 7. pp. 126–128, May 17, 1902.)—This is a 5-ton lorry driven by a 4-cylinder petrol engine, capable of developing 24 b.h.p. The main underframe is constructed of channel steel, and towards its front end is mounted the engine. The power is transmitted through a friction clutch to a four-speed change gear, having spur wheels, which are brought into engagement by side contact. A bevel gear transmits from the upper counter-shaft of the change gear to the differential cross-shaft, and the final transmission to the rear road wheels is by independent chain drives. The four forward speeds, and one reverse, are all controlled by a single lever. The steering wheels are pivoted on the Ackerman system, and controlled by a hand wheel operating through a worm and sector gear. C. R. D'E.

1785. *Brazier Gasoline Automobile.* (Horseless Age, 9. pp. 559–560, May 7, 1902.)—This is an American touring car constructed on lines similar to those of many French cars. The engine is of the double cylinder vertical type, fitted with electric ignition, and rated at 18 b.h.p. at 800 r.p.m. It is mounted towards the front of the underframe, and covered by a sheet-metal bonnet. The power is transmitted through a cone friction clutch, with surfaces arranged to eliminate end thrust while the power is on, to a three-speed change gear, and finally, by a flexible tail shaft and bevel gearing to the live rear axle. The car weighs about 2,100 lbs. complete with body. C. R. D'E.

1786. *Daimler Motor Launch.* (Engineering, 73. p. 678, May 23, 1902.)—This article describes a motor launch which has been built for use at Shoeburyness in towing targets to and from their stations during artillery practice. The motor is of the usual Daimler type, and is capable, when running at its full speed of 700 r.p.m., of developing 22 h.p., with a consumption of about one pint of petrol per h.p. per hour. The motor flywheel drives the propeller shaft through a spring clutch coupling, and the propeller is provided with adjustable reversing blades. The contract speed of the launch was 7 miles per hour, but the actual speed attained on its trial trip was between 10 and 11 miles per hour. Four different means are provided for varying the speed of the launch: (1) By altering the angle of the propeller blades while running at constant speed; (2) by regulating the volume of the explosive charge supplied to the engine; (3) by timing the ignition; and (4) by the action of the governor in cutting out explosions. A characteristic feature in the launch is the method of preventing sand and grit from lodging in the stern-post propeller shaft bearing, by enclosing it in a chamber supplied with exhaust pressure gases from the engine. Lubrication is effected by dropping oil into the pipe supplying this chamber, the exhaust gases carrying the oil to the bearing. The arrangement of the propelling mechanism of the launch is clearly shown in the illustrations which accompany the article. J. G.

REFERENCES.

1787. *Wigzell Steam Engine.* **R. J. Isaacson.** (Mech. Eng. 9. pp. 561–563, April 26, 1902. Paper read before the Engineering Society, Oct. 28, 1901.) [See Abstract No. 199 (1901).] H. R. C.

1788. *Evolution of the Shaft Governor.* **C. Carpenter.** (Power, N.Y. 22. pp. 4–7, March, 1902. Paper read at the meeting of the Engine Builders' Ass., New York, Dec., 1901.)—This paper is mainly historical, and contains a list of early United States patents from 1839 to 1880. G. W. DE T.

1789. *Transverse Stresses in Steam-pipes.* **A. S. Mann.** (Amer. Electn. 14. pp. 110–112, March, 1902.)—This is a continuation of a former paper. [See Abstract No. 968 (1902).] H. R. C.

1790. *Circulation in Water-tube Boilers.* **A. C. Elliott.** (Engineering, 73. pp. 495–498, April 18, 1902.)—A theoretical investigation of the water circulation in the Belleville boiler. H. R. C.

1791. *Water-Softening.* (Tram. Rly. World, 11. pp. 235–236, April, 1902.)—This article gives a general account of the treatment of water containing calcium sulphate and magnesium carbonate, but no calcium carbonate, for use in steam boilers. [See also Abstracts Nos. 202, 2233 (1901), and 155 (1902).] F. J. R.

1792. *Gas-Engine Calculation.* **R. Barkow.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1640–1642, Nov. 16, 1901, and 46. pp. 81–83, Jan. 18, 1902.)—Investigations of the average pressures during the different portions of the cycles of gas-engines are here made, and deductions are drawn with respect to the best conditions of action, but these rest on uncertain assumptions. R. E. B

GENERAL ELECTRICAL ENGINEERING.

1793. *Friction and Wear in Toothed Gearing.* **K. Büchner.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 159–166, Feb. 1, and pp. 278–284, Feb. 22, 1902.)—The teeth are worn away mainly owing to the fact that they slide to some extent upon one another in addition to the rolling motion that takes place; in this way the material is gradually removed as a result of the rubbing. Moreover, in consequence of shocks of various kinds, the teeth become crushed and flattened. The author examines the result produced by the sliding motion of the teeth upon one another. This depends on the normal pressure between the teeth, and on the amount of the so-called specific sliding, *i.e.*, on the proportion which the sliding bears to the travel of the teeth on each other at each instant. A graphic method is given for determining the normal pressure in the case of teeth formed according to Lindner's method, and also on the involute and cycloidal methods. Similarly, the specific sliding is determined by graphical methods in the three cases, and also by analytical methods in the case of involute and cycloïdal teeth. The wear on the teeth is proportional to the product of the normal pressure, the specific sliding, and the speed of revolution, apart from considerations of the coefficient of friction, and the breadth of the teeth. These products are worked out for the various forms of teeth, and when plotted out constitute the "wear-characteristics," which are very different for the various forms of tooth, the wear being moreover unequal on the driving and driven tooth. The theoretical results do not agree entirely with those obtained practically. This partly arises from the fact that wear causes gradual alterations in the shape of the teeth, and it is not possible to take this into account theoretically. It is nevertheless possible to foresee the probable amount of wear under any given conditions. A general outline is given of the form of toothed gearing used by the Allgemeine Elektrizitäts Gesellschaft. It is of the involute form, and the arc of approach is kept as small as possible. The larger wheel has teeth with considerable depth below the pitch line, and a small amount above, whereas the smaller wheel is constructed on precisely opposite principles. Particulars are also given of the gearing used by de Laval in connection with his turbines; the teeth are kept as small as possible, and have a height of 2·7 mm. on a wheel with a pitch circle of 360 mm. diameter. In this way the arc of contact is kept as small as possible. W. H. S.

1794. *Hydraulic Turbine Governor.* (Amer. Electn. 14. pp. 240–242, May, 1902.)—In the Sturgess governor the main gate of the turbine is controlled by a rotary piston which makes 0·87 of a revolution. Water is admitted to one side or the other by means of a piston valve, which is itself moved by hydraulic pressure, controlled by a small central valve connected to a centrifugal governor. In order to check any tendency to hunt, each movement of the main shaft is caused, through the intermediary of a dash-pot, to alter the size of an expanding pulley on the governor shaft. Thus if the speed of the turbine increases, the governor partially closes the gate, but the movement of this latter expands the pulley of the governor, and reduces its speed relatively to that of the turbine itself, thus preventing instability. A. E. L.

GENERATORS, MOTORS, AND TRANSFORMERS.

1795. *Design of Continuous-Current Dynamos.* **R. Kennedy.** (Elect. Rev. 50. pp. 899–900, May 30, 1902.)—The author gives a formula for determining the total magnetic flux through the armature in Kapp lines $Z = \sqrt{\text{kw.}} \times 200$. This assumes a speed of 1,000 for all machines; for a lower speed divide 1,000 by the number required to bring it down to the given speed, and multiply the constant 200 by the square root of this number; for a higher speed multiply 1,000 by the number required to bring it up to the given speed, and divide the constant 200 by the square root of this number. Then the number of turns on the armature $= E \times 10^8/Zn$, where $n =$ the speed. R. B. R.

1796. *Concatenation of Induction Motors.* **E. Danielson.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 439–451, April, 1902.)—With two motors having different numbers of poles, four different speeds are in general obtainable, viz., that due to the natural speed of each motor, that due to the ordinary arrangement in concatenation, and that due to concatenation with the connections reversed. Thus with a four-pole and a ten-pole motor on a 50 ∿ circuit, the four-pole motor alone will give a speed of 1,500 r.p.m., the ten-pole motor alone 600 r.p.m., the ordinary concatenation 428 r.p.m., and the so-called "differential concatenation" 1,000 r.p.m. The application of this principle to traction is discussed, and the following table is given as showing the input required for unit mechanical output with different arrangements of direct-current and induction motors. The full-load efficiency is in every case taken as 92 per cent.

	Accelerating only.		Accelerating and electrically braking.	
	Without gearing.	With gearing.	Without gearing.	With gearing.
Direct-current motor, resistance entirely cut out at ⅔ full speed	1·33	1·4	1·33	1·4
Direct-current motor, resistance entirely cut out at ¾ full speed	1·4	1·48	1·4	1·48
Induction motor, simple	2·17	2·29	2·17	2·29
Induction motors, regular concatenated connection	1·68	1·77	1·36	1·47
Induction motors, three speeds, 0·4 : 0·67 : 1	1·5	1·58	1·17	1·27
Induction motors, four speeds, 0·285 : 0·4 : 0·67 : 1	1·45	1·52	1·15	1·24

A. E. L.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1797. *Economical Loss of Pressure in Conductors.* **A. della Riccia.** (Assoc. Ing. Él. Liège, Bull. 2. pp. 20–41, Jan., 1902.)—When the problem is to transmit power by means of a simple electric line, the economical rule of Kelvin, in which the best conditions of working are such that the annual costs of interest and depreciation of the copper in the line are equal to the cost of annual loss of energy in the same, leads to two conclusions, viz. :—1. That under these conditions the loss of pressure in the line is fixed, and independent of the pressure either at the transmitting or receiving end, and also of the power transmitted ; it is simply proportional to the length of the line. 2. That the density of current is fixed and independent of the pressure chosen, of the power transmitted, and of the distance to which it is transmitted. When it is a question of feeding a network by means of several feeders, one cannot generally adopt on each of these lines the economical density, because (by conclusion 1) the pressure at each feeding-point would not be the same. It is generally arranged that the loss of pressure shall be the same on the different feeders. The author proceeds to show mathematically and graphically what is the most economical loss of pressure to adopt in the feeders, under such conditions, both for lighting and traction networks ; and discusses also the use of regulating rheostats and boosters. The lead and return feeders are calculated separately for lighting and traction systems, and formulæ given for each. F. B.

1798. *Isolated Plants* v. *The Central Station.* (Elect. World and Engineer, 39. pp. 817–819, May, 10, 1902.)—This is an abstract of a discussion which took place before the Chicago Electrical Association. **C. A. Dresser,** who opened the discussion, expressed no decided opinion ; he calculated that if an isolated plant had a load of 80 h.p. for 10 hours a day for 300 days in the year, the cost of power, if generated by steam, would be 2.85 cents per kw.-hour, after making a certain allowance for the utilisation of the exhaust steam for heating purposes. **S. M. Bushnell** followed with a lengthy argument in favour of the central station, the main point being that it relieved the consumer from various anxieties. **J. Mabbs** said that the Board of Trade had installed plant for the purposes of their building, and the cost of power was now one-half of what it would be with central-station supply, and they practically heated their building free of cost for seven months in the year. Current is sold by meter to tenants on the basis of 10 cents per kw.-hour with a sliding scale which gives a consumer of 1,000 kw.-hours per month a rate of 5 cents per kw.-hour. W. H. S.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1799. *Power Transmission Plant in New Zealand.* **O. Haes.** (Electrician, 48. pp. 396–397, Dec. 27, 1901. Abstract of paper read before the Electrical Association of New South Wales.)—The author describes a small plant which derives its power from a fall on the Kaituna River, and transmits it thence over a distance of 18 miles to the town of Rotorua. There are two turbines, each giving 100 b.h.p. at 117 r.p.m., with a head of 14 ft. These drive 50-kw. alternators by means of belts, the output being given at any pressure between 3,200 and 4,200 volts, and on the single-phase system. The installation was primarily intended to drive some sewage pumps; but in addition a certain amount of lighting is carried out in the town. W. H. S.

1800. *Cincinnati Gas and Electric Company's Light and Power System.* (Elect. World and Engineer, 39. pp. 848–850, May 17, 1902.)—This paper deals with the new power and lighting scheme which has resulted from the consolidation of the interests of the three electric companies formerly controlled by the Cincinnati Gas and Electric Light Company. Instead of supplying energy from four different central stations, the whole supply will now be distributed from a single station, which is that formerly used by the Cincinnati Edison Electric Company, but now considerably enlarged and altered. The bulk of the distribution mains were formerly overhead, but these are now placed underground, except in the outlying portions of the town. The total area to be supplied is 43 square miles, and the greatest distance from the station to which current is transmitted is 8 miles. At present, underground conduits are being laid in 43 miles of streets. Continuous-current series arcs are employed for the street lighting, the 3,408 lamps formerly employed, and yielding a revenue of approximately £17 each per annum, will be replaced by 4,400 enclosed alternating-current series lamps, taking 4 amperes at 75 volts each. For these lamps, the contract price for current is about £14 per annum in the underground distribution districts, and £12 in the outlying overhead supply district. The underground lighting and power network is supplied by direct-current generators at 110 and 220 volts, and the remainder of the current will be generated as 60-cycle three-phase alternating current, with 4,000 volts between each phase, and 2,300 volts between each leg and the neutral wire of the circuit, when star-connected. The arcs are supplied by separate G.E. "tub" transformers, each capable of giving current for 60 lights; and for the outlying districts, the transformers, or the motors, where motors are to be supplied, are delta-connected to the three outer legs of the circuit, without making use of the neutral wire. For lighting, the transformers are connected between the outside legs of the 4,000-volt circuit and the neutral wire. The transformers are distributed so as to maintain the phases of the circuits as nearly as possible in balance. The generating plant will consist of one 2,500-kw. three-phase Bullock alternator and four 450-kw. direct-current generators, and, in addition to the latter, for supplying the underground network at light-load periods, two 500-kw. motor-generator sets will be used. These motor-generators are designed to take three-phase current at 4,000 volts, and generate direct current at 300 volts for the outer wires of the low-tension network. The characteristic feature of this plant is the three-phase generator, which is designed for 2,500-kw. normal load, and 3,120-kw. continuous overload. It will generate 4,500 volts between its terminals at a speed of 75 r.p.m. It is the largest machine of the kind in America, having 96 poles, and therefore presenting considerable difficulties in its construction over the large machines operating at the low frequency of 25 cycles usually employed. The design adopted is that of the flywheel type of machine; its external diameter is 34 ft. and its internal diameter 30 ft. Full details of the weights of the several parts of this machine, and the electrical guarantees, are also given. The article, which is fully illustrated, concludes by a description of the card system employed for keeping the station records. J. G.

1801. *The Lighting Plant at Jumet.* **R. Berger.** (Assoc. Ing. Él. Liège, Bull. 2. pp. 42–62, Jan., 1902.)—In this commune (which is near Charleroi, Belgium, and is of a diameter varying from 5 to 7 km.) the lighting is on the 3-wire continuous-current system, with overhead conductors, and 440 volts across the extremes; nine feeders with pilot wires are employed, and the neutral conductor is earthed. The generating station contains two 150-h.p. (French) Preud'homme compound condensing engines, running at 85 r.p.m., supplied with steam by three Cornwall-Galloway boilers by Germeau, each having 70 sq. m. heating surface and working at 9 atmospheres; two of them are sufficient for the daily load, the other being used as a reserve. There are two 100-kw. 8-pole belt-driven dynamos giving 500 volts at 365 r.p.m. and two 18-kw. dynamos for the accumulators; these latter run at 1,050 r.p.m., and their voltage can be varied from 250 to 340 volts by means of resistances in their shunt circuits. The switchboard permits the two 100-kw. dynamos to be put in parallel, with the battery, or the 18-kw. equalisers, connected to the neutral point; the network to be fed by the battery alone, or by the two equalisers alone, or by the battery in parallel with the equalisers; the battery is charged by the equalisers, or by the 100-kw. dynamos. The cut-outs are Edison plugs with silver wire fuses. The bare conductors extend from a pole of sheet iron, eight metres high, having ⊔-section rings to receive the insulators. The accumulators are of the Hagen type, with 268 cells, having a capacity of 440 ampere-hours at a 10-hour discharge-rate; 370 ampere-hours at a 5-hour rate (the normal); and 300 ampere-hours at a 3-hour rate. There are 1,340 16-c.p. lamps 40 m. apart, distributed over 66 km. of roads, and 1,800 similar lamps for private consumers are provided for. The calculated loss at full load at the ends of the feeders is 50 volts. The conductors are supported on wooden masts 8·5 m. high, impregnated with cyanide of potassium, and provided with double-bell porcelain insulators. The poles where the feeders join the network have cabins at the base containing switchboards, on which are mounted lightning protectors, fuses, and an electromagnetic switch controlled by pilot wires from the generating station, and serving for connecting and disconnecting the street lamp circuit. The price of a kw.-hour for private consumers has been fixed at 0·4 franc for lighting and 0·18 franc for power. C. K. F.

1802. *The Lighting of Bergen County, N. J.* **W. J. Jones.** (Elect. World and Engineer, 39. pp. 899–902, May 24, 1902.)—The lighting is undertaken by a company, which supplies current in about fifty towns, over an area of 160 square miles. Two-phase alternating current is generated at 2,500 volts. Various systems of running incandescent lamps in series for street-lighting purposes are described in outline, nearly all being operated with film cut-outs. W. H. S.

1803. *Hudson Valley Railway.* (Street Rly. Rev. 12. pp. 193–200, April, 1902.)—The total length of the line is 103 miles, the track consisting for the most part of 60 or 70-lb. T-rails on ties 6 in. by 6 in. by 8 ft. The trolley wire is No. 000 gauge of figure 8 section. There are five direct-current stations owned by the company, which were taken over at the times when the various companies operating in the district were consolidated. They contain more or less antiquated plant; but it is now proposed to replace them by a three-phase 22,000-volt transmission scheme with substations of 300 kw. capacity at intervals of 10 miles along the railway. The plant is to be worked by water power. W. H. S.

1804. *Grimsby and Cleethorpes Electric Tramways.* (Tram. Rly. World, 11. pp. 285–289, May, 1902.)—The notable feature of this line is that the cars are worked by current obtained from the Grimsby Electricity Works [see Abstract No. 1810 (1901)] when they pass through the streets of the borough, and from a power station owned by the Tramway Company when they pass on to the Cleethorpes section of the system. The tramway line consists, for the most part, of double track laid down to the standard gauge, and is about 6 miles in length. The whole of the track work was carried out by the company's workmen, and it consists of a 6-in. bed of concrete covered with granite paving sets. The girder rails weigh about 90 lbs. per yard, and are, for the greater part, 6½ in. deep. Fish-plates 24 in. long, are secured to the rails at each joint by six 1-in. bolts. Each joint is double-bonded, and cross track bonds are inserted about every 40 yards, whilst the double screw tie-rods are placed every 8 to 10 ft. apart. The tramway and railway crossings have received special attention, and two sets of figures are given, which clearly show how this part of the work has been carried out; whilst two other figures show how the system of feeders, and the pilot and telephone cables have been put down. Three other figures are devoted to the side, and the centre pole systems of trolley wire construction. The whole of the feeder cables are drawn into earthenware conduits, with surface boxes about 100 yards apart. The cast-iron feeder pillars are of rectangular section, and are fitted with two locked doors. By opening these doors, the front and the back of the insulating slab, with all the necessary switches (for the to and from feeder cables) the lightning arrester, and the terminals for the pilot and telephone wires are readily accessible for fixing or adjusting the cable ends, or for merely closing and opening the feeder switches. The company's power-house steam-raising equipment consists of two ordinary double flue cross-tube Lancashire boilers, each 28 ft. long by 7 ft. 6 in. in diameter; a 96 tube economiser, and two feed-pumps, each capable of delivering 4,000 lbs. of water per hour, against a boiler pressure of 125 lbs. All the feed-water piping is in duplicate, and these, as well as the steam-pipes, are made of steel, with screwed-on flanges; whilst the exhaust, and the ordinary water-pipes, are of cast iron. Two horizontal tandem compound condensing steam engines are each capable of developing 250 i.h.p. when running at 200 r.p.m., and each is coupled direct to a 150-kw. continuous current 550-volt generator. The switchboard is of the usual panel pattern, and is fitted with all the necessary switches and instruments for complying with the Board of Trade regulations. Three photographic views are devoted to the engine-room, containing the two prime movers, two generators and the switchboard; whilst one of these shows the very necessary 10-ton travelling crane. The remaining two figures show the entrance curves to and from the car shed, as well as a photographic end view of the latter with its eight parallel rows of stabled cars. The whole forms an instructive example of the traction plant and equipment required by a small provincial town or district. A. J.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1805. *Magnetic Effect of Leakage Currents.* **E. B. Wedmore.** (Inst. Elect. Engin., Journ. 31. pp. 576–592; Discussion, pp. 592–610, March, 1902.) —Considering the return current of a tramway line, if the whole current returns by the rails, the magnetic effects due to the current in the trolley-wires and rails would practically cancel, except in the immediate neighbourhood. When the current returns partly by the earth and at a distance from the trolley wire, the magnetic effects of the current in the latter is not so cancelled. Assuming that the specific conductivity of the earth is uniform, and that the return currents enter and leave at points, no part of the vertical component due to the trolley wires and feeders is cancelled by the earth currents. In the immediate neighbourhood of the track the current in the trolley wire will have a considerable horizontal component, but at a distance this will be wholly due to the earth currents. If the current be assumed to enter and leave the earth along vertical wires, a distance d apart, the horizontal component at a point distant r_1 and r_2 from the two points is $\frac{cd}{r_1 r_2}$ in absolute units, c being the current. If the current be fed along a wire between the two points, the vertical component at the point considered is $\frac{c}{l}(\cos\theta_1 + \cos\theta_2)$, where l is the perpendicular distance from the point to the wire, and θ_1 and θ_2 are the angles between the wire and r_1 and r_2 respectively. When, in a tramway system, points are suitably selected at which it may be said that the current enters and leaves the earth, the author finds that these formulæ give quite as accurate results as the more complex formulæ given by Parry [see Abstract No. 2514 (1900)] and Rücker [see Abstract No. 1600 (1901)]. Edler suggests [see Abstract No. 208 (1900)] that the return currents are carried by a layer of damp ground extending only a small depth below the surface. The formulæ would be equally applicable if this were the case. The author gives values of the horizontal and vertical magnetic components obtained from actual measurement, and compares these with the calculated values. The distribution of current in the earth cannot be calculated until it be known whether it flows in a plane of relatively small thickness or through the body of the earth. If all the resistance between two points on the rail be assumed to be that offered by the earth, the specific resistance of this can be calculated. From his measurements the author finds this to be 75 ohms per cubic yard. He gives the following formula for the apparent resistance to the body of the earth offered by a pipe of radius r per square inch of pipe surface: $R = 6{,}000\, r\,(3 - \log r)$. The author shows that by connecting pipes to the rails no current need leak from the pipe; the pipe, however, will carry a larger current, which may leave or re-enter the pipe at the joints. His recommendations are to use cast-iron joints, to avoid all connections with the rails, and to introduce as far as possible resistance in the joints and on the pipe surface.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Discussion.—**R. T. Glazebrook** gave a table comparing the figures deduced from his theory with those from Edler's experiments; the vertical component only is given, and it is stated that the agreement is not so good in the case of the horizontal component. **A. P. Trotter** described some experiments made in the neighbourhood of Cape Town on normal earth currents and leakage currents from the tramways. The former could often be reversed in direction by wetting the ground near one earth-plate. He is inclined to think it better to connect pipes with the rails, and does not believe that under English conditions the current in the pipe would be increased to the extent Wedmore supposes. He finally describes models showing the equipotential lines and lines of flow when current is fed into one side of a uniformly conducting sheet and tapped at different points. **E. O. Walker** stated as his experience that the earth is practically nonconductive for 4 or 5 ft. down, and that the good conducting strata are the water-bearing strata 30 or 40 ft. down. If current passes out from a pipe it will gradually decrease owing to the formation of a layer of oxide. He thinks the damage done by chemical action is much larger than any due to electrolysis. **H. M. Sayers** referred to a tramway where the conductivity of the track varied considerably with the state of the weather. He considers it inadvisable to connect the pipes and rails unless the pipes have been laid in such a way as to ensure good electrical contact at the joints. In laying pipes for tramway feeders he does this, and connects the pipes to the rails. **W. M. Mordey** pointed out that though pipes have been said to suffer from electrolysis only since tramways started, yet there always existed earth currents; he has worked a motor from these in the early days of telegraphy, and has found differences of potential of over 40 volts in 17 miles. G. H. B.

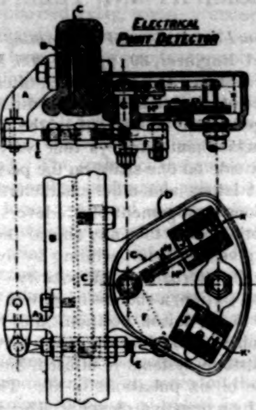
1806. *Automatic Block Signals on the Pennsylvania Railroad.* (Railroad Gazette, 34. pp. 355–357, May 16, 1902.)—Practically there are automatic track-circuit block-signals all the way from Jersey City to Paoli, about 104 miles, and the line is almost entirely four-track. The block sections are all less than 1 mile long, and, in addition to the block signalling, the stations and yards are nearly all equipped with complete interlocking apparatus. Switches, which are not connected with a cabin, and interlocked, have electrical connections to short-circuit the current of the track battery whenever the switch is not set straight for the main line, thus putting signals to "stop" at entrances to block sections. Semaphores are normally at "clear." Each becomes horizontal immediately after the locomotive passes it. All the block signals are Westinghouse electro-pneumatic. The newest features of the system are shown between Philadelphia and Paoli, 17 miles. Signals are on steel bracket-posts at the side of the road. The power is compressed air, but electric current is supplied by a storage battery of 2 cells at each post, an iron box at the base containing battery and relays. The dynamo for charging is at Radnor, 13 miles from Philadelphia, and the feed-wire, No. 6 copper, insulated, is on poles. The batteries supply current for the track-circuits as well as for the signal instruments. At Radnor also are the air compressors. The power, which is mostly used for pumping water to tanks, is furnished by two 125-h.p. locomotive boilers; the compressors are Ingersoll-Sergeant Duplex, with compound air-cylinders and inter-cooler in base. The dynamos are 500-volt Westinghouse shunt-wound, directly connected to Westinghouse engines, each of 12¼ h.p. Bracket-posts are used instead of bridges, because the stations are so close together, and in order to put the signals in the most suitable positions for starting at the stations. The longest section is only 1,327 yards. The main air-pipe is laid in the ground between the two inner tracks. The air and electricity only require a small part of the power provided at Radnor. The interlocking apparatus (mechanical) for the switches and signals at the principal stations existed before the automatic signals were put up. The signals are on bridges, each over the track to which it relates. They have been made "semi-automatic" by attaching a pneumatic air cylinder to each main line high-speed semaphore, and introducing a track circuit with the usual relay: the controlling wires run to circuit breakers on the different switch and signal levers in the cabin. The leverman is thus enabled to "clear" the signal when the track is clear, and the train in passing puts it to "danger." In the New York division, 90 miles, the signalling is similar to that described above. Each block section is worked by a single track-circuit, usually 3,000 to

4,000 ft. long, with a home and a distant signal at the entrance of each section. For interlocking, there are 36 plants of the Saxby and Farmer improved mechanical or manual type, and 4 Westinghouse electro-pneumatic, with a number of others, under construction. Compressed air is supplied from a 2-in. main pipe along the whole line. The compressors in continuous service average about 11 miles apart, and are at water and coal stations; there are 6 reserve compressors. There are in all 1,856 signals. The wires are underground, and served during a severe storm last winter to keep the system in regular operation when overhead circuits were crippled. A polarised or wireless system of control is in use on about 20 miles. Pressure recording gauges for the main air-pipe are located at convenient points. Through-trains overtaking local stopping trains on a passenger track are, when possible, shifted over to a freight track. In such a case the despatcher would simply direct the operator where the local train happens to be, to move the through-train from the one track to the other, which he would do by setting the proper cross-over and signals. The through-train, without stopping, would then run from No. 1 to No. 2 track, the local train continuing on No. 1. The former would be brought back to No. 1 track at the next possible place without stopping and without the issue of any orders, the signals directing the movements, and the interlocking and block system providing full protection for both trains at every step of the journey. Where there are no telegraph offices, telephones have been established at the signal bridges, connected to the nearest interlocking towers for prompt report of any unusual occurrence. The safety of the system was tested in an unusual storm last winter, when all telegraph wires were out of use. For 30 hours the trains ran absolutely by the automatic block signals, aided by the operators at the interlocking towers. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

1807. *Knewe Enclosed Arc Lamp.* (Electrician, 49. pp. 50–51, May 2, 1902.)—In this lamp there is only one globe, and the upper carbon holder is made in the form of a split cap to be sprung on to the top of the upper carbon. This cap bears a piston-shaped series of copper gauze washers which slide in a central metal tube through which the current passes to the upper carbon. The middle part of the upper carbon is centred by means of the ring clutch, which is made externally in the form of a ball, to fit easily into the central metal tube. This clutch rests at the bottom on a collar secured to the the lamp-frame, and is provided at the side with an arm connected to a lever controlled by the regulating solenoid of the lamp. The lamp is trimmed through a 3½-in. hole at the bottom of the globe. C. K. F.

1808. *Electric Signalling. W. R. Sykes' System.* (Tram. Rly. World, 11. pp. 292–295, May, 1902.)—The system as used on the Waterloo and City Railway was described in Abstract No. 2042 (1901). It is worth while, however, to reproduce the drawing of the point detector which plays so important a part in lock and block, and to explain the same briefly. All facing points are fitted with this device, which is easily fixed and maintained. It is placed in a fan-shaped cast-iron case, one being fixed to each stock rail on a pair of points, and connected and working with the tongues. A is a crank-arm bolted to the tongue B, C a stock rail, D a cast-iron case, F and G cranks attached to springs H H′, which connect with contact-plates J and K in one direction, and J′ K′ in the other. When the tongues of the points are properly home (the detector can be so adjusted that these tongues must be actually dead home before it is operative), the springs H H′ mounted on the crank G would be in contact with the plates J and K, completing a circuit through both detectors, and releasing an electric lock on the tappet of the lever working the signal controlling these points. If now the points are pulled over, the springs H H′ would come in contact with J′ K′, completing a circuit, and unlocking the lever working the signal for this direction. If both tongues are not properly home, the circuit remains broken, and the signal-lever is locked by the electric lock on the tappet.



Point Detector.

E. O. W.

REFERENCE.

1809. *Conversion to Overhead Trolley System of the Englewood Storage-Battery Road.* (West. Electn. 29. pp. 216–217, 1901.)

TELEGRAPHY AND TELEPHONY.

1810. *The Buckingham Long-Distance Page-Printing Telegraph.* **W. Maver, Jr.** (Elect. World and Engineer, 39. pp. 902–908, May 24, 1902.)—To save the time involved in revolving the type-wheel, often the greater part of a revolution, in order to print some letters, as in ordinary type-printers, and to reduce the number of pulsations of current to the lowest number possible, the inventor, C. L. Buckingham, employs four very small octagonal type-wheels, mounted side by side on one shaft, on the periphery of each of which wheels are placed eight letters and other characters. The shaft is so disposed that, by an ingenious arrangement of five levers, it may be given both a lateral and a rotary motion, such that any one of the thirty-two characters may be placed before a given point for printing by five pulsations of current—that is, two and a half alternations of polarity—from the transmitting station. At the receiving station, a succession of five short pulsations always brings the escape wheel to the unison position. For the actual printing of a letter, the pulsation required to produce the space between letters and words in the Morse and Wheatstone systems is utilised, but for the selection and printing, there is a cycle of six pulsations in all. The space, as in Wheatstone's system, is made by a negative current. The alphabet is so arranged that the letters that occur most frequently involve few prolonged impulses. Time is saved in this way. For preparing a tape, a keyboard perforator is used, an improvement on the Wheatstone perforator, inasmuch as the operator has only to depress one key to effect perforations for one letter. The rate at which a Wheatstone puncher can be operated is from twenty to forty words per minute, but in Buckingham's system a skilled operator can do eighty words. When a key is pressed, it makes contact by means of inverted stirrups fixed underneath it, with stretched wires which work crank levers, the latter bringing certain electromagnets into play. These latter operate the punches, of which there are sixteen, eight in each of two rows, one row for the upper, and one row for the lower holes in the tape. A key will cause six punches to work, making three upper and three lower holes in the exact order required for the transmission of the letter to which the key belongs. The central holes in the tape are prepared in advance at high speed in a separate machine. As the letters are of variable length, a variable tape feed is effected automatically by a drum carrying small teeth, which engage the central holes of the tape. The drum is on a vertical shaft, driven by a motor-wound barrel spring. Round the edge of the drum are movable pins. One of the pins is always raised above the normal, and engaging a stop, prevents the drum going round. When a key is pressed, a "feed" magnet forces up another pin at an appropriate distance from the first, and on release of the key, another magnet causes a hammer to strike down the first pin, letting the drum revolve till caught by the second pin, and the punched paper is thus pulled through the proper distance. There is a device for indicating the end of a line to the operator, who then depresses a line space key. The method of transmission is identical with that of the Wheatstone Automatic. To avoid the delay that the movement of a paper carriage would cause, the inventor has a novel device in arranging the telegraph blanks at the receiving station in the form of a tube, which is placed loosely over a fixed tubular support; along the margin of the blanks is a row of small holes in which a star-wheel engages. This wheel is motor-wound and clock-spring driven, but its movement is controlled by the printer escapement. For advancing the tube of paper at the end of a line, there is a slanting groove within, which guides the star-wheel to a new set of perforations. There is, for receipt of signals, one main line polarised relay, whose armature controls two branch circuits, in which are the escapement magnet, the unison magnet, and the governing relay. These have each two coils reversely wound. The armature of the first oscillates with that of the main line relay. The second is polarised, and its armature is controlled by a spring, so that only prolonged negative currents will affect it. Each letter is followed by such a current, and the hook connected to this armature thus controls the unison wheel, which is on the same shaft as the escape wheel. The spring of the governing relay is arranged to allow the armature to respond to prolonged pulses of either polarity. There are six circuit-closing levers, actuated successively by teeth of the unison wheel, five of them communicating with selecting relays through the armature of the governing relay. These selecting relays work the type-wheel magnets. The sixth circuit-closing lever works the sixth pulse relay, which is concerned with the restoring relay, the press magnet, the feed magnet, an ink-ribbon magnet, and a dogging magnet; this last serves to lock the type-wheel in a given position, by a pin engaging in holes in a cylinder until the printing is effected. Whenever, in the course of the incoming six pulses that represent and print a character, one or more of the pulses are prolonged, there will also be a prolonged pulse or pulses in the local circuit of the governing relay, which will move its armature. Supposing it is the first pulse. Lever No. 1 is on a tooth of the unison wheel, and pressed against No. 1 contact post. No. 1 selecting relay is in circuit with the dynamo, its armature is thrown over, and causes type-magnet No. 1 to work. This last moves the type-wheel into a position for printing a letter corresponding to a first long pulse. In the inventor's code this is A. If there be no other prolonged pulses in the cycle up to the sixth pulse, the letter A will be printed by the sixth pulse. Had the third and fifth pulses also been prolonged, the third and fifth selecting relays would have been operated, with the result that the letter K would have been printed, as, in the code adopted, this letter consists of three dashes separated by spaces equal to dots. The type-wheel has to assume any one of thirty-two positions, and the mode by which it is caused to do this is so ingenious and novel that it deserves to be explained at length by aid of a diagram. The type-wheel is securely mounted with the dogging cylinder on a horizontal shaft. This shaft receives an endwise motion from the horizontal levers on the left, and a rotary motion from those on the right. In shop phrase, these horizontal levers are termed whiffletrees. The vertical arms 4, 5, connected with the type-lever magnets 4, 5, move the horizontal levers which give the endwise motion to the type-wheel. The arms 1, 2, 3 move the right-hand levers, which impart, by suitable intervening mechanism, the rotary motion to the type-wheel. The whiffletrees are connected by suitable links and pins to their respective arms, and are so pivoted and interlinked that a movement of arm 5, for example, to the right, will move the type-wheel (whose shaft is attached by a swivel connection to the left-hand levers) a distance equal to the width of one of the type-wheel rings to the left. When arm 4 only is moved, it shoves the type-wheel shaft lengthwise a distance of two rings of the type-wheel to the right. When both arms are moved, the type-wheel is moved a distance equal to one ring to the right. As in the normal position of the type-wheel, the second ring from the right is in the printing position, it is clear that either of the other three rings may be brought into a printing position by the single and combined effects of two endwise adjusting arms. The lengthwise or reciprocal movements of the right-hand levers impart a rotary motion to the type-wheel shaft by the intermediary of a spiral slot in a sleeve through which a pin attached to a rod *R* projects. This rod is connected by a link to the right-hand whiffletrees. The type-wheel shaft enters the left end of the same sleeve, in which it moves freely lengthwise. A pin on this shaft projects through a straight slot in such manner that when the sleeve rotates in either direction the pin compels the type-wheel shaft to turn with it. The rotating levers are so adjusted that arm 1, when moved alone to the left by its magnet, will turn the type-wheel as a whole one-half of a revolution in the direction of the arrow shown at the shaft. Arm 2, when moved alone to the right, turns the type-wheel two-eighths of a revolution in an opposite direction. Arm 3, moved alone to the right, turns the type-wheel one-eighth of a revolution in the same direction as arm 2. Arms 2 and 3, acting together, jointly turn the type-wheel three-eighths of a revolution in a direction opposite to the arrow, while arms 1 and 2, acting together, but oppositely, will turn the type-wheel two-eighths of a revolution in the direction of the arrow ; and by these means any one of the characters on the type-wheel may be placed in the position for printing, with a maximum of five prolonged pulses, apart from the final prolonged negative pulse for printing and restoring the apparatus to normal after printing. Between New York and Chicago, 974 miles, with Wheatstone repeaters at Buffalo, on overhead copper circuits duplexed, the Buckingham system deals with one hundred average messages per hour in each direction. E. O. W